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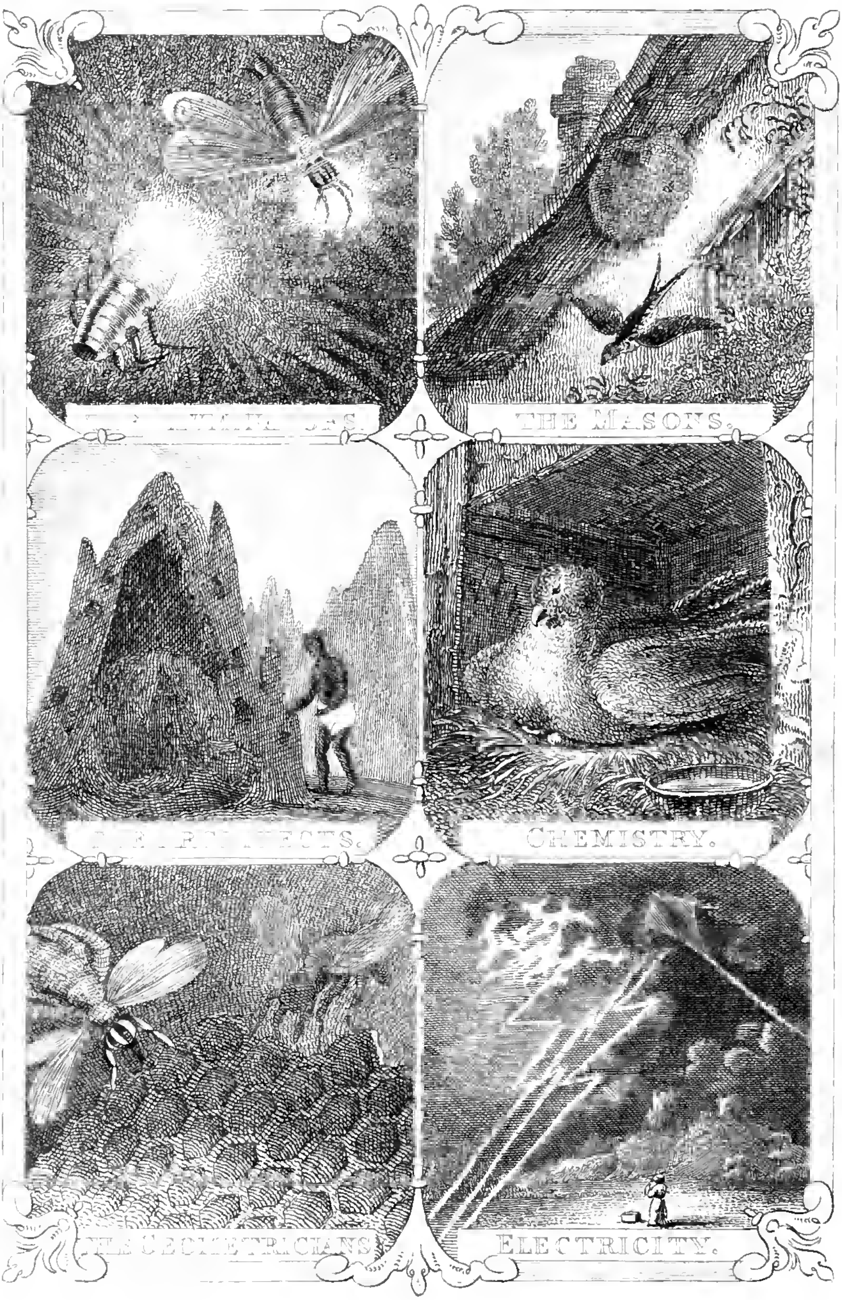
AND

SCIENCE ANTICIPATED.



F. Westley & A. H. Davis, Stationers Court.

ART IN NATURE,

AND

SCIENCE ANTICIPATED.

BY CHARLES WILLIAMS.

"——— Nature's art
Still *unimpaired*—still *unimproved* remains."
MONTGOMERY.

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INTRODUCTION.

The eye of a mother is, perhaps, glancing over this page; and, accustomed to observe her children, she will remember how often the flower blooming in the meadows, and the gay insect fluttering by, have attracted their attention and stimulated their inquiries. Here, then, is a basis on which a knowledge of natural history may be laid; and much that is interesting may assuredly be communicated, even in childhood. Sympathy with the feelings of

the poet,* so beautifully described in his address to the nightingale, is, therefore, a most desirable indication of parental love :—

"That strain again ?
Full fain it would delay me ! My dear babe,
Who, capable of no articulate sound,
Mars all things with his imitative lisp,
How he would place his hand beside his ear,
His little hand, the small fore-finger up,
And bid us listen ! And *I deem it wise*
To make him Nature's playmate."

What objects of beauty, interest, and wonder appeal to us, whenever we escape the error and folly of those *who, seeing, see not !* To give only one instance,—none, perhaps, is more appropriate than that which appears in the just yet glowing language of Linnæus : "See the large, elegant painted wings of

* Coleridge.

the butterfly, four in number, covered with delicate feathery scales! With these it sustains itself in the air a whole day, rivalling the flight of birds, and the brilliancy of the peacock. Consider this insect through the wonderful progress of its life; how different is the first period of its being from the second, and both from the parent insect! Its changes are an inexplicable enigma to us. We see a green caterpillar, furnished with sixteen feet, feeding upon the leaves of a plant; this is changed into a chrysalis, smooth, of golden lustre, hanging suspended to a fixed point, without feet, and subsisting without food. This insect again undergoes another transformation, acquires wings, and six feet, and becomes a gay butterfly, sporting in the air, and living, by suction, upon the honey of plants. What has nature produced

more worthy of our admiration than such an animal coming upon the stage of the world, and playing its part there under so many different masks?"

There is one most interesting point of view in which animated nature has, as yet, been but little regarded. It has been said, indeed, that the Nautilus suggested the construction and use of sails; but, though this is certainly not *impossible*, it partakes of little more *probability* than the idea would, that the divisions of houses into rooms, or the construction of domes, colonnades, and staircases was borrowed from the architecture of ants; or that tapestry and carpets originated with the provision of them by other insects. An accurate and intelligent study of the natural world will, however, render it indisputable, that, though the "lord of the

creation" often plumes himself on his inventive and observing powers, and is too complacent in his enumeration of the arts he practises, and of the sciences he loves, He, who has "all the treasures of wisdom and knowledge," has taught inferior creatures to anticipate him in many of them, of which this volume will furnish ample and conclusive evidence.

The parties who engage in the following conversations might be particularly described: their history might be minutely traced; and, according to modern practice, a graphical account might be given of the spot where they live, the romantic scenery surrounding it, and the delightful blending of luxuriant valleys with richly-covered hills; but it is thought they introduce themselves so fully as to render any assistance altogether unnecessary.

One fact, however, they seem never to overlook, and on the mind and heart of all who are now to form their acquaintance it should be indelibly impressed:—

> "Nature is but a name for an effect
> Whose cause is GOD."

CONTENTS.

ART IN NATURE.

THE PAPER-MAKERS.*

"Oh, papa!" said Emma Elwood, "how I like to walk with you! What a delightful day it is! I *do* feel *so happy!*"

"I am glad of it, my love," replied her father. "I accompany you to-day to reward your good conduct, and that of Frederick; and you may be assured it will always augment my happiness to increase yours. The day is indeed most favourable. How bright and cheerful every thing seems! The birds pour forth their sweetest notes! What tribes of insects sport in the sunbeams; and how active are all the tenants of the hive! Now, we have reached the edge of the heath, where the broom is so richly adorned with its golden

* This conversation is the only one of the series which has previously appeared; it was published in the "Juvenile Forget-me-not" for 1832.

clusters; before us the young corn is shooting from Farmer Selwyn's fields; the hedges are full of the blossoms of the beautiful and fragrant hawthorn; even the banks have flowers gaily creeping over them; —and look at that row of chestnuts skirting the wood —what noble trees!—what promise of fruit! We have been looking, however, at art as well as nature; and when you reach home, my dears, you must tell mamma all you can remember about Mr. Thompson's paper-mill. Were you not much surprised and pleased, Emma?"

"Yes, papa, very much; but I was wondering what people did before they had paper."

"Frederick can tell you, love," said Mr. Elwood, "for I told him just before we set out."

"I have not forgotten, papa," said Frederick: "the most ancient way of writing was on bricks, tiles, oyster-shells, and tables of stone; and afterwards on plates of different metals, on ivory, and on barks and leaves of trees, of which specimens may still be seen in the British Museum. The ancient Arabs carved remarkable events, with a knife, on the shoulder-bones of sheep, and, tying them with a string, hung them up in their cabinets. Skins of animals were sometimes resorted to; and at length the papyrus, or paper-rush, superseded, in Egypt, all other materials."

"You are quite right, Frederick. What did Mr. Thompson say about the first paper-mill?"

F. He said that it was erected by a German, at Dartford, in Kent, in 1588; but that it was not till 1713 that the art of paper-making was brought to perfection, by Thomas Watkins.

Mr. E. Very true; but what will you say when I tell you that paper was made hundreds of years before it was manufactured by *men;* and that they might have learned the whole process by observing the movements of *wasps?*

E. Wasps, did you say, papa? I always think them most disagreeable creatures, and get out of their way lest they should sting me.

Mr. E. Ah, Emma! wasps, like other things, are often thought of very differently from what they ought to be. They are, in fact, peaceably disposed towards men. Reaumur, the great naturalist, states, that they will not attack those who look quietly at them, and that he has seen ladies allow them to settle on their hands. But here is our favourite tree, with a seat round the trunk; let us sit down in the shade of its foliage, and I will give you full proof of their great sagacity.

E. Oh, do, *do,* papa!

Mr. E. Every colony of wasps is founded by a single female, who has survived the rigours of winter, which have proved fatal to her former associates; and who, as soon as she is awoke from her wintry sleep by the genial beams of spring, begins her labours.

F. But where, papa, does she build her nest?

Mr. E. Different species choose different places. One of them* boldly swings its nest, in the northern parts of our island, from the extremity of the broad, flat branch of the silver fir, which defends it from the rain and sun; another† attaches its nest to the branch of a thorn, the stem of a nettle, or stalks of grass; but the common wasp‡ examines the holes in hedge-banks, particularly where field-mice have burrowed. Should she fail here, she digs the earth with her strong mandibles, or jaws, carries it off or pushes it out as she proceeds, forms a small entrance, which runs in a tortuous, or winding direction from one to two feet deep, and prepares a chamber, between one and two feet in diameter, where she lays the foundation of her intended city, beginning with the walls.

E. What materials does she use, papa?

Mr. E. It was long a matter of conjecture; but, after twenty years' observation, Reaumur made the discovery. He found that wasps will use paper ready made, when it can be procured; and that, instead of collecting the farina of flowers, and digesting it into wax, they gnaw small fibres of wood from the sashes of windows, the posts and doors of gardens, or old rails, which their strong and serrated, or saw-like jaws

* Vespa Britannica. † Epipone Nidulans. ‡ Vespa Vulgaris.

enable them to do easily. As the paper-maker first soaks the vegetable fibre in water, so the wasp uses the filaments of wet wood which has rotted in the rain, and, having kneaded them into a sort of paste, or papier maché, begins to line with it the roof of her chamber, — for she builds downwards. She then forms the round ball of fibres, previously kneaded, into a leaf; walking backwards and spreading it out with her mandibles, her tongue, and her feet, till it is almost as thin as tissue paper.

F. But, papa, a sheet of tissue paper would not keep the earth from falling in.

Mr. E. It would not, my dear; and so she spreads one layer upon another, until she has made the wall nearly two inches thick, with open spaces between each layer—that the rain may not so easily penetrate, and that as few materials as possible may be used.

E. That is very curious; pray what does she next?

Mr. E. As soon as the ceiling is finished, the mother-wasp begins the first terrace of her city, which she suspends horizontally, thus forming a hanging floor, which is fastened by from twelve to thirty rods of similar materials, to the roof. The terrace itself is circular, and composed of an immense number of hexagonal, or six-sided cells, formed of the paper I have described, filling every hair's-breadth

of the space, and wholly appropriated to the rearing of the young.

E. And how are the young reared, papa?

Mr. E. As soon as a few cells are constructed, the wasp, who has all this time been toiling alone, deposits in them a few eggs of working wasps, which are fixed so strongly against the sides of the cells by a gluten, or sticky substance, that it is not easy to separate them unbroken. When they are hatched, it is amusing to see the activity with which the female runs from cell to cell, putting her head into those in which the larva, or grub, is very young, while the more advanced thrust their heads out and seem to ask for food. These she feeds, until they become pupæ, or reach the second stage of transformation which all insects undergo,—in which they remain some days, and from which they then emerge in their perfect state; and, within twelve hours after, they eagerly set to work constructing cells, and lightening their parent's labour, by feeding the grubs of other workers and females which are by this time born.

F. Where do they get the food, papa?

Mr. E. In various places to which they resort in their predatory excursions. One party visits a sugar hogshead, or a pear, or peach-tree, while another assails a butcher's stall, from which they will return with well-filled bodies, or pieces as large as they can carry. A wasp will watch for hours at the

door of a hive, pounce on some bee about to enter, and separate, in a trice, the parts which are soft and juicy from those which are dry and hard; and these, with blue-bottle flies, are its most delicate morsels. As soon as it is filled it returns to the nest, where it is surrounded by those whose labours kept them at home, to each of whom it gives a portion of what it has brought, who distribute the food, varying the quantity according to the age of the larva. Those who feed on fruit do not forget the necessities of their comrades, but disgorge a clear drop, which others suck up with avidity.

E. What a number of labourers then there soon is, papa!

Mr. E. Yes, my love; and these enlarge the original coping by side walls, and form another platform of cells, suspended by little rods to the first, as that was to the ceiling, the rods being made narrower towards the middle and widening at each end,—no doubt to render their hold the stronger. Thus several platforms of combs are successively formed, the outer wall being extended at the same time; and by the end of the summer they generally amount to from twelve to fifteen, each containing about one thousand and sixty cells, forty-nine being contained in an inch and a half square, and making about sixteen thousand in one colony.

F. What is the outside like?

Mr. E. The figure of the vespiary, as it is called, is not unlike a large bottle of Indian rubber, but the surface seems as if it were composed of oyster-shells fastened to one another; it is of various colours, owing to the different vegetable fibres used in its fabrication. There are generally two holes, each large enough to admit only a single wasp; one serves for ingress and the other for egress, and such is the order observed, that the uses of the respective doors are rarely, if ever, changed.

E. But how, papa, were all these curious things found out?

Mr. E. By studying the movements of the wasps particularly in glazed hives. The great affection they have for their young gave much opportunity for this purpose, as, though their nest be removed, or even cut in various directions, and exposed to the light, they never abandon their progeny, nor even relax their attention to them. On the removal of a nest to a glass hive, they begin immediately, with amazing activity, to repair any injury it has sustained; carrying off any earth that has fallen, and securing it from further disorder by fixing it to the glass with papyraceous columns like those already described; then repairing the breach, and increasing the thickness of the walls.

E. How long, papa, does a nest last?

Mr. E. Only a year; notwithstanding its population during the summer, it is almost deserted in winter,

and is abandoned entirely in the spring; for then not a single wasp is to be found in the nest of the preceding year.—Now, my dears, I suppose you can tell me who was the first paper-maker!

E. and F. The first wasp, papa.

Mr. E. True, my dears; the instinct of these insects produced effects at once which the powers of man achieved only after long-continued and persevering efforts. What a lesson of humility, then, does this teach us! And how ought we to admire the wisdom and benevolence of that

> ——— *Almighty Being,*
> Cause and support of all things!

Well may we add—

> ——— Can I view
> These objects of my wonder—can I feel
> These fine sensations—and not think of *Thee!*

But who is that I see coming to meet us? It is mamma! And who is that little creature that has just begun to walk? See how he runs a few steps, and then totters and falls! But now he comes steadily. Go, my dears, and lead him to me. Ah! you funny little fellow!—you knew who it was! Now for a jump, jump, jump, and a sweet kiss for papa, Emma, and Frederick.

MECHANICS.

Frederick, accompanied by his sister, had been from home on a visit. Among the objects of interest they had seen, was an exhibition of some very curious pieces of mechanism. There was, for instance, the figure of a little boy, which could write and draw very prettily; another of a lady, which played several tunes on the piano; and many more of birds, reptiles, and insects, whose motions were various and amusing; yet all performed by a kind of clock-work within, by which they were moved.

On relating this to their father, which they did with many expressions of wonder and delight, they were surprised to find, that, while he praised the ingenuity of the mechanic by whom they were contrived, he was not so much amazed as themselves; and that he even promised to tell them of some things still more extraordinary.

Anxious for the fulfilment of his promise, they were glad when he called them one morning into the library, where Mrs. Elwood was also sitting, and commenced the subject as follows :—

"It is remarkable that men proceed slowly in the advancement of science, and even when an improvement

is made, it is found that examples of it exist in the animal kingdom, which ought to have been examined before, and would then have suggested what was required. The perfection of God is stamped upon his works. Those of man are immeasurably inferior. And hence it has been well remarked, that the foundation of the light-house at Eddystone, the perfection of human ingenuity, is not so well arranged as the bones of the foot; that the most perfect pillar is not adjusted so accurately as the hollow bones that support our weight; that a ship's mast is clumsily placed in the hull, when compared with the manner in which the spine, or back-bone, is fastened to other bones; and that the tendons, or twisted fibres, of the body, are composed in a manner superior to the last patent cables of Huddart, or the yet more recently improved chain-cables of Bloxam."

"How I should like to hear about these things!" said Frederick. And Emma was *sure* they would be very amusing.

Mr. E. A dome, you know, is like an orange cut in half, and the flat part placed downwards. Now, we may suppose that the formation of one was the most difficult piece of architecture or building, since the first dome erected appears to have been that of the Pantheon at Rome. The dome of St. Sophia, in Constantinople, fell three times while building; and that of the Cathedral of Florence stood unfinished

one hundred and twenty years, for want of an architect. Yet, you will be surprised when I tell you, that there is a perfect model of a dome in the human head. I cannot show you this so fully as I could wish; but I will mention some things well deserving remembrance. Each stone of a dome must be soldered, or fastened to another, or the whole must be hooped together and girded; thus the dome of St. Paul's has a very strong double iron chain, linked together at the bottom, and several small chains between that and the cupola, or top; and just so, the bones of the head are firmly bound together, so that when every muscle, ligament, and membrane, is gone which could connect them, they are still securely joined, and it requires great art to pull them asunder. To conceive of this, suppose the half of an orange lying flat on a plate, to represent the head, and you will see how difficult it would be for you to press it outwards from the centre where the stem has been, and that so equally, that every part may be pressed alike; and yet, without such a force thus dexterously exerted, the bones of the skull, when every thing is gone but the bone itself, will not give way.

F. Oh, mamma! I almost wish I was a man, that papa might tell me what he cannot now.

Mrs. E. Time flies swiftly, my dear, and if you improve it now, knowledge will be easily acquired by and by.

E. I am getting quite tall, mamma, Mrs. Penrose says; but you know when Frederick is a man, I shall be a woman—that is, if I live. Will you, please, tell us something about the head?

Mrs. E. Its movements are very singular. We want to nod, and stoop, and look up and down, and then we want also to turn the head round some distance. How then, was this to be done? The top of Emma's music-stool will turn round, but then, it will not bend backwards and forwards; and my fore-finger—look—will go backwards and forwards, but then, it will not turn round; how then, was one thing to do both? I will tell you: the head rests on the uppermost of the vertebræ, or bones of the spine, and is fixed to it by *a joint, like a hinge,* so that by this it moves backwards and forwards; and then the second, or uppermost bone but one, has a projection something like a tooth in size and shape, and this enters a hole or socket in the bone above, and forms *a pivot, or axle, on which the upper bone, together with the head it supports, turns freely.* We have a perfect resemblance in the telescope which stands on the table against the window. We want to move the glass up and down, and so you see there is a hinge; and as we want to move it also from side to side, there is, you observe, an axis, or pivot, on which the glass and the hinge turn round together.

Mr. E.—(To Mrs. E.)—The looks of the children

show that they are satisfied and delighted with your explanation. We will now mark the wonderful construction of the spine. It has to unite all parts of the skeleton, not only the bones, but the muscles and the nerves; it has to be a tube to contain the spinal marrow, as important to life as the brain itself, and to distribute it by the nerves through the body; and it has also to be a column, or pillar, to sustain the head; and yet all this it does most completely, though a mechanic would be greatly puzzled were I to ask him to make me a pipe, *out of which* a great number of small ones must go, and *on which* a great many parts must rest, and which, moreover, must be very flexible, and yet very firm.

E. Papa, I was thinking how wise Robert Jenkinson would look were you to ask him to do it; he is, indeed, very clever, and would say, I have no doubt, as he always does, "I'll try, sir;" yet, perhaps, he would never think of examining the spine. But, papa, I hope you are going to tell us how all this is done.

Mr. E. In the human spine there are twenty-four bones, each bending a little, and joined with its fellow, and all yielding in a slight degree; and thus it becomes flexible. Still further, between these bones there is a peculiar gristly substance, which is squeezed out from betwixt the bones, and, therefore, allows them to play a little in the motions of the body; and

it is so ordered, that whenever a weight is upon the body, the gristle is pressed out, and a strong membrane, in which it is enclosed, yields; but the moment the weight is removed, the gristle is pressed into its place, and the bones resume their position.

F. Suppose, papa, there was no gristle, what would happen?

Mr. E. Every motion of the body would give a jar to the brain, so that we should suffer almost as much in alighting on the feet as in falling on the head. But provision is made against another evil. If the spine stood upright, the weight would bear equally—it would yield neither to the one side nor to the other, and, should it give way, it would be with a jerk; but it is made in the form of an italic *ſ*, and thus these difficulties are avoided; and it forms the most perfect spring that could be devised. How should we sympathize with those who are aged! Should an old man fall with his head on the carpet, the blow, which would not hurt a child, may, to him, prove fatal;—why? Because the child's spine is elastic, and his is rigid. Then, as to the spinal marrow, each bone of the spine is so bored through in the middle as that, when put together, the hole in one bone falls into a line, and corresponds with the holes in the two neighbouring bones, and thus, when joined, they form a complete channel; whilst the nerves and muscles are

attached to the spine by means which show the same infinite wisdom.

E. What are muscles, papa?

Mr. E. They are connected with tendons, which appear to consist of a great many fibres, as a rope is formed of a number of threads; but when these fibres are examined, they are found to be a web of most remarkable texture. In like manner, a muscle consists of minute threads, made, as it were, into a bundle, having, perhaps, a million in each. Every muscle is a distinct organ of motion, and there are not less than four hundred and thirty-six muscles in the human frame.

F. How is it, papa, that a muscle is the organ of motion?

Mr. E. It is endowed with a power of contraction, as this bottle of India rubber yields when I press upon it, because it is elastic, and from this, motion originates; but *how* it does so the wisest of men are unable to tell you. You cannot, however, bend and straighten a finger, without the contraction of two muscles taking place. But I will give you a striking proof of the exactness, quickness, and variety of muscular motion. It appears in the human tongue. To utter a single syllable requires a certain action of the tongue, and of the neighbouring parts. The position and shape of the mouth, which are necessary to articulate every letter and word, is not only

peculiar, but may be watched; and hence the deaf are often taught to understand others. After a person has once formed a habit of speaking, one, and only one position of the parts will produce a given sound correctly. And yet, how quickly do the organs of speech take and change these positions! How numerous, various, and yet infallible, are the movements that they make! Now, all this is the work of the muscles; and so numerous and infolded are they, that they cannot be observed, even when the tongue is most minutely examined after death.

E. I never thought, papa, my little noisy tongue was half so wonderful.

Mr. E. The more we use our eyes and our minds, Emma, the more we shall be amazed at what we passed over before without notice. Mamma can relate some remarkable things to you of inferior animals.

Mrs. E. The bones of birds are different from those of other animals. Their cavities are much larger in proportion to the weight of the bone; these cavities are empty, and the shell is of a firmer texture. Birds breathe by means of air-vessels, that are spread through the whole body, and adhere to the under surface of the bones. These, by their motion, force the air through the true lungs, which are very small, somewhat of the shape of the human lungs, and are seated in the uppermost part of the chest, and closely

braced down to the back and ribs. The use of this general diffusion of air through the bodies of birds, is to prevent their breathing being stopped or interrupted by the rapidity of their motion through the air—the resistance increasing in proportion to their speed; so that, were it possible for a man to move as swiftly as a swallow, as he is not provided with air-vessels, like birds, the resistance of the atmosphere would soon suffocate him.

F. Every creature seems adapted to its place.

Mrs. E. It is so. Thus the camel, which lives in sandy deserts, has broad spreading hoofs to support him on the loose soil; and there is a singular and beautiful provision made in his foot, for enabling it to sustain the fatigues of journeys under the pressure of its great weight. In addition to the bones and ligaments, or bindings, which give elasticity to the foot of the deer and other animals, there is, in the camel's foot, between the horny sole and the bones, a cushion, like a ball, of soft matter, almost fluid, but in which there is a mass of threads extremely elastic, interwoven with the pulpy substance. The cushion thus easily changes its shape when pressed; yet it has such a spring, that this huge animal steps as softly as a cat. The second stomach of the camel is, moreover, of very peculiar construction, being formed of numerous cells several inches deep, having their mouths uppermost, and the orifices apparently capable of

muscular contraction. When the animal drinks, it seems to have the power of directing the water into these cells, instead of letting it pass into the first stomach; and, when these are filled, the rest of the water will go into *that*. In this manner, a quantity of water may be kept for several days separate from the food, serving occasionally to moisten it in its passage to the true stomach. No other creature is thus formed.

Mr. E. The rein-deer inhabits a different country —one covered with snow during the greater part of the year. Its hoof is, therefore, admirably formed for passing over what is so cold and light, without sinking in it, or being frozen. The under side is covered entirely with hair, of a warm and close texture; and the hoof altogether is very broad, acting exactly like the snow shoes which men have constructed for giving them a larger standing-space, and thus to avoid sinking. Moreover, the deer spreads the hoof as wide as possible when it touches the ground; but, as this breadth would be inconvenient in the air, by occasioning a greater resistance while he is moving along, no sooner does he lift the hoof than the two parts, into which it is cloven, fall together, and so lessen the surface exposed to the air; just as birds do with their bodies and wings. But we need not go to the burning sands of Arabia, or to the snow-clad mountains and valleys of Iceland, to observe a skilfully-formed foot; the limbs of every horse are very

remarkable. Were the bones of the foot placed in an upright position, they would make a firm pillar, but every motion would cause a shock. They are, therefore, placed obliquely, or slanting, and tied together by an elastic binding on their lower surfaces, so as to form springs as exact as those which are made of steel or leather, for carriages. Then the flatness of the hoof, which stretches out on each side, and the frog coming down in the middle between the quarters, add greatly to its elasticity. The human foot, too, may well excite our astonishment. It is formed of thirty-six bones, to allow of motion, and to give elasticity. There is an arch formed from the heel to the toe, with a bone resembling the key-stone of an arch, but which, instead of being fixed, plays freely between two other bones, for the same purpose; and there is, also, a perfect arch of wedges, regularly formed like the stones of an arch, from side to side; and still further, while they are thus wedged together, like courses of stone for resistance, solidity is combined with elasticity and lightness.

E. Well, papa, that *is* curious. I should never have thought that my shoe contained two arches; and a greater wonder than the suspension-bridge which we saw at Hammersmith! But pray don't stop, papa;—or suppose we give you a little rest, and ask mamma to be so kind as to go on. Oh, I should like it to be for a long time yet!

Mrs. E. I will relate to you, then, one or two facts respecting insects. Many of them have an ovipositor, or instrument by which they lay their eggs in proper places, and where the new-born larva may immediately find the food it likes. Now, this is one of the most striking peculiarities with which the wisdom of the Creator has gifted these little creatures; and, in many cases, it is very wonderful both in its structure and modes of operation. Sometimes it is formed with one part inside another, like the pieces of a telescope; at others it is cylindrical, ending in a pair of joints, which seem to form forceps, or pincers, including a tube, probably to convey the egg to the pincers, which, perhaps, introduces it; in some cases it is straight, in others bent like a sabre; and in the insects noted for their song* we observe five pieces: two form a sheath, two are augers, or borers, and there is a piece between on which they slide, each being furnished with an internal groove for that purpose, and the middle piece with a ridge to fit—a contrivance of Divine Wisdom to prevent their being dislocated, or put out of joint when boring; the augers, too, end in a knob, which is externally toothed.

F. Why, mamma, that is more curious than any carpenter's tool I ever saw; and all this is only part of an insect. Do you remember how it is used?

* Cicada.

Mrs. E. Crane-flies* are so common in some meadows, that, being very shy, and fearful of danger, they rise in swarms at every step; some of them flying high, others only skipping over the grass, and others running and using their long legs as the inhabitants of marshy countries use stilts; and employing their wings, like the ostrich, to aid their limbs. Sometimes they lay their eggs in grass fields, or moist meadows, and sometimes in the tilled ground of gardens and farms. To this the ovipositor, or instrument for depositing the eggs, is well adapted; consisting, as it does, of a sort of horny forceps, or pincers, sharp at the point. The eggs, of which each female lays many hundreds, are very small and black, and like grains of gunpowder. The position she takes seems somewhat awkward, for she raises herself upright on her two hind legs, using her ovipositor as a point of support, and resting with her fore-legs on the neighbouring herbage. She then thrusts her ovipositor into the ground as far as the first ring of her body, and leaves one or more eggs in the hole; and next moves onwards to another place, but without bringing herself into a horizontal position. The grub, when hatched from the egg, immediately attacks the roots of the grass and other herbage which it finds nearest to it; and, of course, the portion of the plant above ground withers for lack of nourishment. Mr. Rennie says he observed, in 1828,

* Tipulæ.

more than an acre of ground, adjoining the garden of the Bishop of Oxford, at Blackheath, as entirely stripped, both of grass and every thing green, as if the turf had been pared off from the surface, only one plant being untouched; and that, on digging to learn the cause, he found these larvæ full fed, and about to pass into pupæ, after having left nothing on which they could subsist.

E. Oh, what sly and hungry little creatures! They eat quite out of sight; and then what quantities they devour!—Now, papa, you have rested a little, and mamma has given us this capital story, can't you give us one more—*only* one more?

Mr. E. Vallisnieri, an eminent Italian naturalist, was the first that observed a most singular instrument in the body of a little four-winged creature, called very properly by Reaumur, the *saw-fly.** The grubs from which these flies come are but too well-known, as they frequently strip our rose, gooseberry, raspberry, and red-currant trees of their leaves; and are no less destructive to birch, alder, and willows, while turnips and wheat suffer still more seriously by their ravages. They may readily be distinguished from the caterpillars of moths and butterflies, by having from sixteen to twenty-eight feet, by which they usually hang to the leaf they feed on, while they coil up the hinder part of their body in a spiral spring. The perfect flies have four transparent wings; and

* Tenthredo.

some of the most common have a flat body of a yellow or orange colour, while the head and shoulders are black.

F. But why, papa, is it called the *saw*-fly?

Mr. E. Because it has in a sheath a very finely contrived saw, made of horn, and adapted for penetrating branches and other parts of plants, where the eggs are to be deposited. It may be compared with the *tenon-saw* used by cabinet-makers, which, being made of a very thin plate of steel, is fitted with a back to prevent its bending. The back is a piece of iron, in which a narrow and deep groove is cut to receive the plate, which is fixed. Now the saw of the fly is also furnished with a back, but the groove is in the plate, and receives a ridge of the back, which is not fixed, but permits the saw to slide forwards or backwards, as it is thrown out or drawn in. The tenon-saw is *single*, but that of the insect is *double*, and consists of two distinct saws with their backs; in using which the creature first throws out one, and, while it is returning, pushes forward the other; and this motion is continued till the incision is made, when the two saws, receding from each other, conduct the egg between them into its place. In the cabinet-maker's saw, the teeth are alternately bent towards the sides, or out of the right line, in order that the fissure, or cut, may be wide enough for the blade to move easily; and, to answer this purpose in some measure, the teeth of the insect's saw are a little

twisted, but the incision is more effectually made by small teeth placed on the outer side of each; so that, while their edge acts like a saw, their sides act as a *rasp*. When, by this curious and complicated machine, the insect has rendered the groove as large as she wishes, and an egg is placed in the cavity, the saw is drawn into its sheath for about two-thirds of its length, and, at the same moment, a sort of frothy liquid, similar to a lather made with soap, is dropped over the egg, either to glue it to its place, or to defend it from the action of the juices of the tree. Reaumur has seen a saw-fly make *six* grooves in succession, which occupied her about ten hours and a half. Now, my dears, are you *quite* tired?

E. Oh, no, papa, not even a little! I could hearken for an hour longer.

Mr. E. We have conversed about the muscles of the human body, but the muscular power of inferior creatures is very remarkable. The kangaroo is hunted by large and powerful dogs of the greyhound species; and, when pursued, makes the most surprising leaps, by means of its long hind legs, clearing bushes, and even trees, of considerable height. At a single spring, they will often reach *six and thirty feet!* and, if their course be down hill, no dog can overtake them. When alarmed, a full-grown bull-frog will sometimes leap three yards; and still further to shew their muscular power, I will give you a story which is well

authenticated. The American Indians are known to be excellent runners, being almost able to equal the best horse in its swiftest course. In order, therefore, to try how well the bull-frogs could leap, some Swedes laid a wager with a young Indian, that he could not overtake one of them, provided it had two leaps beforehand. They carried a bull-frog, which they had caught in a pond, into a field, and cruelly burnt its tail. The fire and the Indian, who endeavoured to outrun it, had such an effect on the frog that it went at its utmost speed. The Indian pursued with all his might; but the little creature reached the pond which was fixed on as the goal, before he could overtake it.

F. Oh, what a race! Are there any more such jumpers?

Mr. E. The flea,* called by the Arabians "the father of leapers," and the locust, jump two hundred times their own length; and, supposing the same relative force to be infused into the body of a man six feet high, he would be able to leap three times the height of St. Paul's.

A man must vault through the air to the distance of a quarter of a mile to equal the leap of the cuckoo-spit frog-hopper. Mouffet says that an English mechanic, to show his skill, constructed a chain of gold as long as his finger, which, together with a lock and key, were dragged along by a single flea.

* Pulex.

A watch-maker, in the Strand, is said to have exhibited a little ivory chaise with four wheels, and all its proper apparatus, and the figure of a man sitting on the box, all of which were drawn by a single flea; and another, it is affirmed, dragged a silver cannon, twenty-four times its own weight, mounted on wheels, and did not manifest any alarm when this was charged with gunpowder and fired off. A stag-beetle,* was once seen carrying a wand a foot and a half long, and half an inch thick, and even flying to the distance of several yards.

F. And do you say this is the power of the muscles?

Mr. E. Yes, it is. "Any lady," says Kirby, "fond of going to be tempted with an exhibition of fine lace, would experience an unexpected gratification could she be brought to examine the muscles of a caterpillar under a microscope—almost all exhibiting the appearance of being woven, and resembling fine lace—one pattern ornamenting one organ, another a second, and another a third." The caterpillar,† or grub of a moth, has raised nearly a hundred times its own weight. It is said to have more than four thousand muscles.—And now, my dears, I think you will be *quite* content.

E. Papa, I won't ask you for any thing more this time; but I am sure we should like to hear all this over again.

* Lucanus cervus. † Cossus ligniperda.

THE CONFECTIONERS.

Spring walks over the earth clothed in beauty as with a garment, and thousands of lovely flowers arise in her footprints.

> "There the rose unveils
> Her breast of beauty, and each delicate bud
> O' the season comes in turn to bloom and perish.
> But first of all the violet, with an eye
> Blue as the midnight heavens; the frail snow-drop,
> Born of the breath of winter, and on his brow
> Fixed like a pale and solitary star;
> The languid hyacinth, and wild primrose,
> And daisy trodden down like modesty;
> The fox-glove, in whose drooping bells the bee
> Makes her sweet music; the tangled woodbine,
> Lilacs, and flowering limes, and scented thorns,
> And some from whom the voluptuous winds of June
> Catch their perfumings."

How delighted are children with them! See, they come joyously with what they have gathered! But they have loaded themselves too much:—one blue flower, and then a yellow one, and now one of crimson, falls from the pinafore to the ground; and in the meadows, some are bounding about "to gather king-cups," or make of them a little heap, and then sort or bind them together, with many a sly antic and merry gambol.

And this feeling seems sometimes "to grow with the growth, and strengthen with the strength." People of early times and distant spots showed its power. Flowers were used at banquets, seattered in the temples, presented on the altars, strewed in the path of conquerors, and offered by the young and the aged as the expression of friendship and of love.

With sueh thoughts as these, Mr. and Mrs. Elwood were walking, preeeded by their two ehildren, one fine morning towards the end of May, when, as they were about to pass a garden in whieh there was a snug and rose-eovered cottage, Mr. Elwood desired his children to stop and observe what was going on. A boy, who had been set to watch the hive, had just given notice of the flight of its inmates, and forthwith a ringing eommeneed with pans and fire-shovels, to "charm them down," as the eountry people say. Happily, the queen-bee quiekly alighted on the end of a bough, and the rest of the bees elustered about her, when the neatly-dressed and healthy-looking eottagers spread a eloth on a table, and, holding an empty hive under the swarm, suddenly shook them into it, and plaeed it, with its eaptives, on the cloth. Then they were earried to the spot they were to oeeupy, on the edge of a flower-bed; and in a few hours, Mr. E. remarked, they would be perfectly contented with their new home.

Frederick and Emma wished to know all about

these wonderful little creatures at once; but their father said he could give the best account of the hive-bee* when he was at home, because he had some books there from which he should like to read the remarks of those who had attentively studied the subject; and, as they were about to return, their patience would not long be exercised.

Accordingly, Mrs. E. had no sooner taken off her bonnet and shawl, and entered the parlour where Mr. E. and his son were seated, than Emma came bounding in, saying, "Now, dear papa, for the bees!"

"Or suppose we call them the confectioners," said her father. "We passed Mr. Duncombe's shop just now, so full of candies, jellies, and preserves; but these little creatures were wholesale manufacturers of sweets even before the flood. In many parts of the east, honey may still be drank from the rock, in cavities of which it is frequently deposited; and doubtless it was often received from thence by the patriarchs themselves. But shall I tell you, my dears, about their making honey *only*, or shall I connect with this some other curious things?"

E. Perhaps, papa, making honey would be a very short story; and the longer one of yours is, the better we like it.

Mr. E. Then I will begin with reading what

* Apis mellifica.

Reaumur says about dividing a swarm—a process like that which you have just seen:—

"After the tumult excited by their removal into a little glass hive was calmed, and I had looked at it for ten minutes, for the first time in my life, I succeeded in seeing a queen-bee, which was walking at the bottom of the case. For the first few minutes, in which I followed her with my eyes, I was tempted to believe that the stories of the respect paid her by the other bees, the train by which she was attended, were fables rather than facts. She was alone, and walking, perhaps, at a slower pace than the rest. The friends who were with me were pleased to discover in her gait something of gravity and majesty. She advanced unattended to one of the squares of the hive, up which she mounted to join a group of her subjects perched at the top. In a little time she appeared at the bottom, but still sadly neglected. She ascended a second time, and I lost sight of her for a few instants; she then appeared for the third time at the bottom of the hive. Now, however, twelve or fifteen bees were ranged around her, and seemed to form her train. In the first moments of trouble and confusion we think only of ourselves If we were in a large saloon, and it had suddenly broken down, in the confusion we should forget that others dearer than ourselves were in the room. Thus it was with these bees; for, being huddled into the

little glass hive, turned topsy-turvy, the first impulse of each seemed self-preservation; and it was only when they had recovered their composure that they began to recollect the mother, which, in their fright, they had forgotten and neglected.

"In spite of my inclination to believe that the first train which I had perceived was the effect of chance—in spite of my disposition to think that a big bee would be followed precisely because it was big—I was forced to acknowledge that there was some other foundation for the homage, the cares, and attentions, which the rest paid to *her* who was destined to be the mother of a numerous progeny. The queen, with her little suite, disappeared for a moment among a cluster of bees. In a short time she reappeared at the bottom of the hive, when a dozen others hastened to join the train. A row flanked her on each side as she walked; others met her before, and made way as she advanced; and in a very short time she was surrounded by a circle of upwards of thirty bees. Some of these, approaching nearer than others, licked her with their trunks; others extended their organ, filled with honey, for her to sip; sometimes I saw her stop to partake of the food; at other times she sucked while in motion."

E. Do they pay the queen so much attention as this, papa?

Mr. E. To try how far their loyalty went, Dr.

Warder ran the hazard of destroying a whole swarm. Having shaken on the grass all the bees from a hive where they had only been settled the day before, he stirred them about with a stick till he found the queen, whom he placed with a few attendants in a box. He took this into his parlour and opened it, when she flew immediately to the window with her attendants. He then cut off one of her wings, and returned her to the box, where he confined her for above an hour. The swarm, in less than a quarter of an hour, ascertained their loss, when, instead of clustering as before in a mass, they spread themselves about, became restless and agitated, and uttered a doleful sound. About an hour after they all took flight, and settled on the hedge where they had first alighted on coming from the parent hive; but instead of hanging together, as is usual with swarms accompanied by a queen, they scattered themselves along the hedge in small parties of forty or fifty. In these circumstances the doctor presented them with their queen, around whom they immediately collected, uttering a joyful hum, and uniting in a suspended cluster. He hived them again at night, and on the following morning tried whether they would rise; for the queen, having lost her wing, could not fly to accompany them; but they staid with her for several hours, appearing to be willing to die rather than leave her. On removing her a second time, they again

spread about, as if in search of her; and when she was restored to them repeatedly, "these poor, loyal, and loving creatures," says the doctor, "always marched and counter-marched every way the queen was laid." He continued the same experiments for five days and five nights, during which they had not tasted food; and at length the whole perished, the queen surviving the others only a short period. He infers that the queen was no less attached to the bees than they to her, for she uniformly refused to take the honey which he offered her when separated from the swarm.

E. Why, papa, the bees loved her as much as we do our good Queen Adelaide; and I dare say she loves us too. But what are the other bees in a swarm?

Mr. E. It consists, first, of *workers*, amounting generally, to many thousands in number, and easily recognized by their smallness and their industry; and, secondly, of *males*, of which several hundreds belong to each community; these are larger than the working bee, and live idly.

F. How do they begin to work, papa?

Mr. E. By searching for pollen, or yellow dust, which lies loosely in the middle of flowers. As the breast, legs, and many other parts of the bee's body, are covered with a fine down or hair, it enters the cup of a flower, rolls itself round, and is soon quite

covered with the yellow dust. The last joint but one of each leg is formed exactly like a brush, and these natural brushes are passed one after another over the various parts of its body to secure the treasure, and to collect it into two little heaps. Th thighs of the last pair of its legs are furnished with two cavities fringed with hair; and these form a convenient little basket for its use. The dust collected from a thousand flowers is kneaded into small pellets, or balls, and stuck into these hollows, and as soon as the balls are as large as a grain of pepper, away flies the insect to place its store in the hive. On reaching it, it enters one of the cells head foremost, takes out the pellets from the cavities, and these, being moistened and mixed with a small portion of honey, are kneaded into a substance called in the country "bee-bread," a proper supply of which is necessary to the health and strength of the bees during the winter season. Without this, they become consumptive and die. Besides this, however, they want propolis.

F. What is that, papa?

Mr. E. A resinous gum found in certain trees, such as the birch, the willow, and the poplar. Near the outlet of one of his hives, Huber placed some branches of the latter, out of which comes a transparent juice of the colour of garnet. On these some worker-bees soon perched. Having taken some of

the gum, they formed it into pellets, put them into the baskets of their thighs, and, thus loaded, flew to the hive, where some of their fellow-labourers instantly came to help them in laying it down; after which the pellets were laid in a little heap as near as possible to the place where they were to be used. A bee then drew out a thread from the mass, which it cut off with its teeth, and held with the claw of one of its feet; and when he came out, one part of the cell was found by this means to be lined and soldered. Others gave him their aid, proceeding from one cell to another, until all the cells destined for the young had been soldered and strengthened by this substance, which is soft at first, and at length becomes much harder than wax.

E. Wax, papa! what is wax?

Mr. E. It is a secretion found in the form of scales under the belly of the bee. Among the workers in a hive, some are architects who plan and build, and, at the same time, nurse the young; and others only bring the materials, but do not give them shape; the former Huber calls the nurse-bees; the latter wax-workers. The wax-workers, then, having filled themselves at the flowers, hang motionless in festoons—that is, like rows of curtains one above another—and, in four-and-twenty hours, thin white scales appear under the rings of the abdomen. Huber watched some doing this, and, at length, saw a bee

come out from the middle of the group, and, clearing a space about an inch round at the top of the hive, applied the pincers of one of its legs to its side, took off a scale of wax, and began to mince it with its tongue, which sometimes appeared like a bricklayer's trowel, then flattened like a spatula, or broad-bladed knife; and, at other times, ending in a point like a pencil. The scale, moistened with a frothy liquid, became glutinous, and was drawn out like a ribbon. This bee, which Huber calls "the founder," then put all the wax it could make to the vault of the hive, and went its way; a second did the like; a third followed, but, owing to some blunder, did not put the wax in the right line, upon which another bee, as if sensible of the defect, removed the misplaced wax, and, carrying it to the former heap, placed it there exactly in the order and direction pointed out.

F. What was done then, papa?

Mr. E. The result of these labours was a little block of wax, fixed to the vault of the hive, running in a straight line, with a rough surface, but round in its edges, half an inch long, a sixth of an inch high, and about the twenty-fourth part of an inch thick. The wax-workers, having got the stock of materials ready, an architect, or nurse-bee, quitted the cluster, examined both sides of the block, felt about with its antennæ, or horns, and then, like a skilful mason, began to scoop out, exactly in the centre, as much of

the block as equalled the size of a common cell; and, after kneading what it had removed, placed it carefully at the sides of the opening. Having done this, it was succeeded by a second bee; and, in this manner, upwards of twenty workers followed each other, each one taking care to push forward the material so as to extend the walls of the cell. When the cell had risen and been extended on one side, a bee quitted the swarm, and, after going round the block, began on the side opposite to that of the first cell, and, assisted by another, sketched out two, so situated, that the partition between them was exactly opposite the first cell on the reverse side. They never at first begin two masses for combs at the same time, but scarcely are some rows of cells formed in the first comb, before two other masses, one on each side of it, are fixed at equal distances from it, and then, again, two more outside these.

F. But, papa, is not the stock of wax they make soon out?

Mr. E. It would be, were not the wax-workers constantly making a fresh supply. Their dispatch is very great. When first settled in a new hive, they will sometimes form a comb twenty-seven inches long, by seven or eight inches wide, in twenty-four hours; and they will half fill the hive in five or six days; thus in the first fifteen days of their possession of a new abode, as much wax is made as they use during the remainder of the year.

E. Of what use are the cells?

Mr. E. The first sort are for the larvæ, or grubs of workers; the second for those of the males, or drones, which are larger, and usually placed in the middle of the comb; the third are the royal cells. Some might suppose that the various cells, composing a cake, are little habitations for the workers to rest in, each in his own house after the labours of the day, but it is not so; some are filled with honey, and others are closed up. Most of the cells, indeed, contain a little worm—the young of the bee, which is an object of the greatest anxiety and care. The mode of rest is singular; four or five cling to a part of the hive, and stretch out their hind legs, to which others cling by their fore-feet; these do the same for another line; and thus at all times bunches, or festoons, of bees, may be seen reposing. Huber, however, has seen the workers retire to a cell and remain motionless for twenty minutes.

F. How long are the bees in growing, papa?

Mr. E. I will read what Huber says, " The worm of the worker takes twenty days the male twenty-four, the queen sixteen days, in reaching maturity. The worker remains three days in the egg, and five in the grub state, when the bees close up its cell with a waxen covering; it is thirty-six hours in spinning its cocoon; in three days it changes to a nymph, or chrysalis, passes six in that form, and then comes

forth a perfect bee. The male passes three days in the egg, six and a half as a worm, and on the twenty-fourth, makes its appearance as a winged animal. The royal insect passes three days in the egg; is five a worm, when the bees close its cell, and it immediately begins its cocoon, which is finished in twenty-four hours. During eleven days, and even sixteen hours of the twelfth, it remains in a state of complete repose. Its transformation into a nymph then takes place, in which state four days and a part of a fifth are passed."

F. Does she lay any eggs?

Mr. E. On the fifth day after her appearance, she quits the hive; forty-six hours after she begins to lay eggs, and a hive will often contain forty thousand inhabitants, the most of them her own offspring. The first eggs of the queen always produce workers. She must be at least eleven months old before she begins to lay the eggs of males; the time she and the workers well know, and they take care to provide suitable cells.

F. That is very strange. Are the queen's cells like the others?

Mr. E. No; they are like a pear with the stem downwards. When the queen lays in them, they are like an acorn-cup, after this they are quite closed up. Careful as the bees are at other times of materials and of space, when their future queen is concerned neither

is grudged. More wax goes to make the cradle of the infant queen than would build a hundred, or a hundred and fifty common cells, and on them no labour is spared.

E. Does a cell ever tumble, papa?

Mr. E. Mr. Walond, on looking at his bee-boxes one day, saw that a centre comb, burdened with honey, had separated, and was leaning against another comb, so as to prevent the passing of the bees between. This accident made the bees very active, but Mr. W. could not see what was done. But, at the end of a week, he found that they had made two horizontal pillars betwixt the two combs, and had taken so much of the honey and wax from the top of each as to allow the passing of a bee; in about ten days more there was a passage quite free,—for the separated comb, at its upper part, had been fastened by a strong barrier, and fixed to the window with the spare wax. This being done, the bees took away the pillars as of no further use.

F. How do the cells look, papa?

Mr. E. As to their shape, I must talk to you another time.* But, while building, they seem to be soft, not smooth, nor yet transparent, but of a dull white colour; in a few days they become tinged with yellow, and their edges become thicker, less regular, heavier, and so tough that they will bend rather

* See The Geometricians.

than break. A glutinous substance may be seen round the opening, and threads of this are applied to various parts, as if to bind and strengthen the walls. This appears to be produced from the propolis of which I have told you. Beside painting and varnishing their cells, as I have just described, they strengthen the weaker parts with a peculiar sort of mortar. And it is remarkable, that, while our houses soon fail and decay, those of the bees grow stronger the oftener they change inhabitants. Every bee-grub, before it changes into a nymph, fastens its skin to the partitions of its cell, but without altering, in the least, the regularity of its figure. Accordingly, the same lodging may serve during summer for three or four grubs one after the other, and, next season, it may be used by an equal number. Reaumur found as many as seven or eight skins spread over one another, so that all the cells, being thus covered again and again, and well dried and cemented with propolis, daily become more solid. When, however, by this means the cells become too small, they are sometimes used as storehouses for bee-bread and honey; and, at others, bees are bred in them; these, therefore, are, of necessity, smaller, and form, in fact, the important class of *nurse-bees*.

E. Papa, how do they get the honey? For you said that, like Duncombe, they were makers of sweets.

Mr. E. It is obtained from that part of a flower called the nectarium. To collect this, the bee has a trunk or tongue, which it can double up or lengthen at pleasure. It is not like a tube by which the fluid is to be sucked up, but like a tongue to lick away the honied juice, which the bee always knows where to find, though it is only lately that skilful botanists knew where it was. This sweet juice, conveyed by the tongue to the mouth, passes into the first stomach, or honey-bag, and, when this is filled, the bee returns to the hive, and taking only a small part for its own use, puts the remainder into one of the cells, or delivers it to another bee at the entrance of the hive, and then flies off for a fresh supply. Some honey-combs are always left open for the common use of the workers, but the greater number of cells filled during the summer are carefully stopped up until the internal supply of honey begins to fail. When, however, the honey is very plentiful, the bees lengthen their cells, or build new ones, in which to store it.

F. Papa, I have just thought of something; can you tell us what is done when a queen dies?

Mr. E. With pleasure, my dear, I answer your question, by relating one of the most astonishing facts in the history of bees. When a queen dies, they proceed to repair the loss. For this purpose they form several of their royal cells, and, taking a

common worker-worm out of the ordinary ones, they put it into a royal eell, feed it with royal food, and, in a few days, the worker becomes a queen. In many parts of Germany, the peasants, knowing this, shut up a few hundred working bees with a pieee of honey-eomb, eontaining eommon grubs three or four days old: the worker-bees immediately set about destroying some of the common eells, make royal cells instead, plaee the grubs in these cells, and give them food proper for grubs whieh are to beeome queens. This experiment never fails. In due time, a number of young queens is produced, all are destroyed but one, and she governs the hive. Thus hives are multiplied at pleasure. And now, my dears, have you any more questions to ask?

F. Not now, papa.

E. I have none, papa; and Frederick, love, *a'n't* you very glad we saw the bee-hive?

THE SILK-MANUFACTURERS.

Mr. Elwood was one morning engaged in the library with Frederick, when Emma came in, and said, as she laid a small yellow ball on the table, "*Do*, papa, tell me what this is, if you please."

"My love," he replied, "it is a very curious thing; it is the work, and the abode for some time, of a silk-worm;* and is called a *cocoon;* as every ball is which is made by an insect while it is a grub."

"But what," enquired Emma, "is there *inside?*"

"The outer part," said her father, "is formed of a rough silk-like substance, called floss; inside this, is a thread more distinct and even; and then the apartment of the chrysalis, or aurelia, which lodges here, seems lined with a substance of the hardness of paper, but much stronger; while the third, which composes the cocoon, is not rolled regularly round, but lies very unevenly upon it, and winds off first from one side and then from the other; and so we get silk for ladies' gowns, and bonnets, and various purposes."

* Phalæna (bombyx) mori.

Frederick laid down his book, the eyes of the children were attentively fixed on the little wonder, and, after turning it over again and again, the following conversation took place.

E. How much silk is there in a cocoon, papa?

Mr. E. The quantity is variously stated, and some times most absurdly exaggerated—thus, Isward, an old author, says, it will measure in length six miles, or 10,560 yards; but Count Dandolo tells us, that a silkworm's labours seldom exceed 625 yards; a great quantity indeed for so short a life. Others consider the average length to be from 300 to 400 yards, and the weight to be about three grains.

F. Who first used the work of this little creature?

Mr. E. It is difficult to say positively who it was, or when it was done. The credit of drawing the slender filament from these little balls, from which fabrics may be formed of endless beauty and variety, is claimed by the Chinese. It is stated in their records, that they used the work of the silk-worm two thousand seven hundred years before the Christian era; they represent the Empresses as surrounded by their women, engaged in hatching and rearing the little manufacturers, and in weaving their valuable produce; and they give the honour of doing this *first* to one who was named See-ling-shee.

E. But, papa, how did *we* get it first?

Mr. E. A long time passed before it was known in

England, and even then it was very slowly introduced. Soon after the Conquest, however, it was much used; and, in 1251, when Alexander III. of Scotland, married Margaret, the daughter of Henry III., a thousand English knights appeared in garments of silk, which were thrown aside the next day for robes equally gorgeous and splendid.

E. O, papa, how I should have liked to see them! And then, I dare say, the ladies were quite as handsomely dressed. How gay they must all have looked! —and, dear!—how much money it must have cost!

Mr. E. Silk, my love, was at one time valued, at Rome, at its weight in gold; and the Emperor Aurelian is said to have refused his Empress a robe of silk because it was so costly. Even when James VI., King of Scotland, came to assume the English crown, it was so scarce that he was obliged to ask the Earl of Mar for the loan of a pair of silk stockings to wear before the English Ambassador, adding, "For ye would not, sure, that your king should appear as a scrub before strangers."

F. Well, papa, I should think there must be plenty now. I was with mamma the other day when Mr. Wilkinson called, and told her so much about his stock selling off—sarsnets, and satins, and gros—gros—

E. Gros de Naples; yes, papa, and Levantines, and lustres, and poplins, and velvets, and brocades, and,— and—

Mr. E. That will do, my dears; the variety is greater than you, Emma, or any other little girl, can describe. The quantity too is immense. When the frame-work knitters of silk stockings petitioned Oliver Cromwell for a charter, they said, "The Englishman buys silk of the stranger for twenty marks, and sells him the same again for one hundred pounds." But now, we buy three millions and a half pounds of raw silk from the stranger, employ half a million of our own people in the manufacture of it by the aid of machinery, and sell it to them and the stranger, at a price as low as that of the calico of half a century ago.

F. What a number of silk-worms then there must be!

Mr. E. Yes! To supply this *one* luxury to *us*, fourteen thousand millions of animated creatures yearly live, labour, and die! Still greater must be the number in China, where all, from the emperor to the peasant, wear silk.

E. Dear papa, tell us how it is made; I am sure I want to know all about it; and Frederick is looking so slyly, as if he meant to say so too.

Mr. E. Silk-worms are hatched from eggs, laid during summer, by a kind of greyish moth; they are about as large as a grain of mustard-seed, at first of a yellow colour, but afterwards of a blueish hue. From each of these comes a small black caterpillar; in about eight days its head grows larger, and it is seized with

its first sickness, when its size increases; and in the course of a month, its weight is multiplied many *thousand-fold.* It then throws off its whole covering, not only that of the body, but of the feet, of the entire skull, and even of the mandibles, or jaws; which process may be seen by the unassisted eye, but, of course, more clearly through a magnifying glass.

E. Well! that is strange! Does it change any more?

Mr. E. Yes! It is again attacked by sickness, after which it moults again; and, when this has been repeated for the fourth time, the caterpillar is about one and a half or two inches long, devours its food most voraciously, and, during ten days, increases rapidly in size. Its whole form is now remarkable; but the two very small apertures through which the worm draws its silky substanee, are placed just beneath the jaw, and close to each other.

F. Now, I should think it is ready for work.

Mr. E. Almost, my dear; it ceases to feed on the mulberry leaves; its colour is now light-green, with a mixture of a darker hue; and, in twenty-four hours, the material for forming its silk is digested, when its green colour disappears, its body acquires greater firmness and is somewhat lessened in size, and it finds some place for its work, and begins its cocoon.

F. But where is the substanee of which the silk is composed?

Mr. E. It is secreted in the form of a fine yellow transparent gum in two small separate vessels, which are wound as it were on two spindles in the stomach, and, which unfolded, are about ten inches long. In three or four days, the cocoon is complete; the caterpillar then smears its surface with a gum like that which forms the silk itself (no doubt to shield the chrysalis from the rain,) a portion of which accompanies the silken filament through its entire length; and so completely is this done, that when, in order to reel the silk more easily, the balls are thrown into hot water, they float like bladders, and, unless the ball is imperfectly formed, the water does not penetrate the silk until it is nearly all unwound. When the ball is finished, the insect rests awhile, throws off its garb, and appears, when the cocoon is opened, something like a kidney-bean in shape, or pointed at one end; having a smooth, brown skin, with its former covering lying by its side.

E. How long does it sleep, papa?

Mr. E. From fifteen to thirty days, according to the climate. It then throws off its shroud, and appears as a large moth of a greyish white colour, with four wings, two eyes, and two black antennæ, or horns; seeks its mate, who deposits her eggs; and both, in two or three days after, end their being.

F. Do any other creatures yield silk?

Mr. E. Yes; some kinds of spiders. According to M.

Bon, the silk formed by them is as beautiful, strong, and glossy, as that of the silk-worms. The spider spins minute fibres from small papillæ, or nipples, placed on the hinder part of its body, and from these he forms or moulds a viscous liquor, which, after being drawn through them, dries on exposure to the air, and becomes silk. M. Reaumur found that each of these nipples consists of many smaller ones, which can only be discerned by their effects. M. Bon was able to count fifteen or twenty fibres in a single thread, while Reaumur relates, that he has discovered, through a microscope, seventy or eighty, and found there were infinitely more than he could reckon, so that he believed himself to be far within the limit of truth when he supposed that one slender filament of a spider's web is made up of 5000 fibres. The thread which forms the web to entrap the prey is very fragile; but those which are wound very loosely round the eggs, in a shape like that of the silkworm's cocoon, after it has been prepared and loosened for the distaff, are much stronger.

F. Were many of these bags collected?

Mr. E. Yes, by M. Bon, from which a new kind of silk was made, said to be inferior in no respect to that of the silkworm. It took readily all kinds of dyes; and stockings, and gloves were made from it, some of which he presented to the Royal Society of London, and others to the Royal Academy of Paris. But,

what will you say, my dears, when I tell you that silk has been sought beneath the surface of the sea, and from a creature ranking in the scale of creation but little higher than a vegetable?

E. I should say, papa, you surprise me very much; but I think you cannot make me wonder more than you have done already.

Mr. E. The pinna* belongs to the same order as the common muscle. Its shell is formed of two parts or valves, fragile, and furnished with a beard; the valves hinge without a tooth. The animal sticks its sharp end into the mud or sand, while the rest of the shell is at liberty to open in the water, and, like the muscle, has the power of spinning a viscid matter in the manner of the spider and caterpillar. Although the shell is often two feet long, the threads are scarcely inferior in beauty and fineness to those of the silk-worm. Separately, they possess but little strength; yet an immense number of them is sufficient to secure the fish in a fixed situation, and naturalists call it "*the silk-worm of the sea.*" It is furnished with an organ, which, in shape, resembles a tongue, and is, therefore, often called by that name; but, whenever the fish wishes to change its place, it serves to drag the body forward, and may then be called a leg, for it is fixed to some solid body, and, being then contracted in its length,

* Pinna ingens.

the fish is necessarily drawn to the spot where it has fixed itself, and, repeating this movement, arrives at its destination. The principal use of this organ, however, is in spinning the threads; for it becomes cylindrical, or round, at the base or root, and a slit runs through its entire length, which acts as a canal for the liquor of which the threads are made, and moulds them into their proper form;—the liquor being secreted by glands or vessels found in all animals, and formed for the production of moisture, with which it is provided. The caterpillar resembles, however, the wire-drawer at work, and the muscle the founder who casts metals in a mould.

F. Were the threads of the pinna ever employed for any valuable purpose?

Mr. E. Yes. They were wrought into gloves and other articles of ornament and dress, in very early times, and a robe, presented by one of the Roman Emperors to the satraps of Armenia, was probably made of this material. Several beautiful things are also made of them at Palermo. The delicacy of the thread, however, is such that a pair of stockings, made of it, may be contained in a snuff-box of ordinary size. Some stockings of this silk were presented, in 1754, to Pope Benedict XIV., and, though so very fine, protected the legs alike from cold and heat. In gouty and rheumatic cases, stockings and gloves of this material are still deemed useful; but it is not seen in England,

except in the cabinets of the curious. Thus, as it has been well remarked, the same silky substance is manufactured by the fish, the caterpillar, and the spider; anticipating by ages some of the costly productions of man.

E. Thank you, thank you, dear papa; how interesting all this is! I am very glad that I found the cocoon!

PNEUMATICS.

"How do you do, this morning, dear mamma?" said Frederick, as he entered the breakfast-parlour.

"I am not quite well, my love," replied Mrs. Elwood; "the wind has been so high during the night that I could get but little sleep. I was thinking of those who were tossed to and fro on the mighty deep, and wishing that none might sustain injury. What scenes of grandeur have I witnessed when staying on the coast! All, perhaps, was calm and sun-bright—the vessels floated in the harbour, and others sailed hither and thither as on a sea of glass; when suddenly a storm came on, and the waves rolled and foamed as if lashed into a mighty rage—and the spray dashed over houses, piers, and rocks—and the vessels seemed struggling with the billows, and anxious to break from the anchors which held them fast.

"'Oh! storm and darkness, ye are wond'rous strong!'"

Recurring to this some time after, Mr. Elwood said, "Emma, can you tell me what wind is?" To which she answered very properly, "Air in motion."

He then asked Frederick if he thought air were light or heavy; and, after some hesitation, he replied, he thought it must be light; besides, he had heard persons speak of "trifles *light* as *air*." The following conversation afterwards took place.

Mr. E. You are mistaken, my dear; the air is much heavier than you suppose. Its particles, indeed, are small; but, then, think of their number. The atmosphere is said to rise about forty-four miles from the earth, and its gravity or weight is such, that a man of middle size is reckoned, when the air is heaviest, to bear upon him the weight of about fourteen tons, or one thousand five hundred and sixty-eight pounds.

E. Dear, papa! how is it, then, he is not crushed to pieces? He would be if a great house or rock fell upon him.

Mr. E. The reason is, because he has air *inside* as well as *outside*, and the pressure on every part of the body is equal. If, however, the air be taken, as it may be by an air-pump, out of a glass—a tumbler for instance—the pressure of the air *outside* will shiver it to atoms. A similar effect will be produced in every case in which the air is exhausted, or drawn out of a vessel, except it be sufficiently strong to resist the external pressure. Suppose, for example, two brass cups be made just to fit one in the other without being screwed, so as to form a globe, and the air *inside* be removed, the air will press them on the

outside so much as to hold them firmly together, and, perhaps, will not let them be separated until the air is let in again. Its weight is nearly fifteen pounds on every square inch; if, then, we could entirely squeeze out the air between our two hands, they would cling together with a force equal to the pressure of double this weight, because the air would press upon both hands; and, could we contrive to suck out the air between one hand and the wall, the hand would stick fast to the wall, being pressed on it with the weight of more than *two hundred pounds*.

E. I am quite sure it is so, papa, because you say it is; but I should not like to *feel* that it was.

Mr. E. Frederick, can you tell me how it is that the common fly * can walk, as it does, up walls or on ceilings?

F. No, papa. But I should be glad if you will tell me!

Mr. E. This has been discovered but very lately. Some persons have thought they had sponges on their feet, filled with a kind of gluten, or sticky substance, which enabled them to adhere to such surfaces. Others supposed that the feet were beset with small bristles, which answered a like purpose. But it has been placed beyond all doubt by Sir Everard Home. He examined flies, and other insects of the same description, and found, by the microscope, that their feet have flat skins or flaps, like the feet of ducks and

* Musca domestica.

geese, and other animals which are web-footed; and towards the back part, or heel, but inside the skin or flap, two very small toes, so connected with the flap as to draw it close down upon the glass or wall the fly walks upon, and to squeeze out the air between the foot, and the glass, or wall. Now, then, I think you can tell me, Frederick, what will be the consequence.

F. I should think, papa—yes, I'm sure I should—that the air being taken from under, the pressure of it above will keep the foot fast on the wall or glass.

Mr. E. Just so; when it wants to move its feet it lets the air under again, and thus it can move or stop at pleasure. There is also a little creature, the lava of a small moth which infests the leaves of pear-trees; on the under surface you may frequently observe several perpendicular, downy, russet-coloured projections, about a quarter of an inch high, and not much thicker than a pin; and if you detach one of them, and give it a gentle squeeze, a small caterpillar, with a yellowish body and black head, will be seen to issue forth. Now, the most curious circumstance in its history is, the mode by which it keeps its tent erect. This is partly done by silken threads; but, being not merely a mechanic, but a philosopher, acquainted with the properties of air, it forms a *vacuum*—that is, it draws out the air from the lower part, and

thus as effectually fastens it to the leaf, as if an *air-pump, which has not yet been invented two hundred years,* had been employed.

F. Oh, papa, how can it do this?

Mr. E. By retreating, on the least alarm, up its narrow case, which its body completely fills, and thus leaving the space below free of air. Of this you may easily be convinced. If you seize one of the cases suddenly, while the insect is at the bottom, you will find it is readily pulled off, the silken cords giving way to a very slight force; but if, proceeding gently, you give the insect time to retreat, the case will be held so closely to the leaf as to require a much stronger effort to loosen it. And, as if aware that, should air get in from below, a vacuum could not be formed, the little philosopher *carefully avoids gnawing a hole in the leaf.* But, Emma, have you ever observed that erect plant, with its spire of crimson bells, spotted or plain, which is called fox-glove by peasants, and digitalis by botanists, and which the young like, because of the pop, pop, pop, which may be made with its flowers?

E. Oh, yes, papa!—and I asked Frederick one day what that hard name, digitalis, meant; and he told me the finger of a glove, which the bells are just like; but, then, he could not tell me why the flower is called *fox*-glove.

Mr. E. Perhaps from its growing in the haunts of

foxes. Now, the bees reach the fine dust and juices of these flowers, and of other hollow ones, like the honey-suckle, by the pressure of the air. They fill up the mouth of the flower with their bodies, and suck out a large part of the air; and the air outside makes the soft sides of the flower close, and squeezes the dust and juice towards the insect as well as a hand could do.

E. That's very curious. He gets what he wants, though he knows not how. But I need not wonder; for when, papa, you ask me *why* a thing is so, how silly I look! Yet *he* is only an insect, and I am a little girl.

Mr. E. Yes, my love, we ought to be "wiser than the beasts of the field and the fowls of the air," for "there is a spirit in man;" and yet many fall, by evil conduct, far below these creatures. But how much more might I tell you! If, for example, you carefully examine a rose-tree, or any other plant, some portion of it will be found covered with little green transparent insects, called aphides, or plant-lice, all engaged in sucking out the juices of the plant. The length of the sucker, or pump, extends, in some species, beyond the body; commonly, however, its length is about one-third that of the insect. Sometimes two rows of them may be observed, one over the other, the second, or upper layer, walking freely over the first; and what is remarkable, the parts to which

these creatures are attached do not wither, but often enlarge or twist, and, by so doing, shelter their foes. The insect chooses the hollow of a shoot, for example, and this, through loss of juice, being diverted from its straightness, becomes like a cork-screw in shape, and, in the hollow, the aphis screens itself from the weather. Still further, as the shoot is thus curled, the leaves which would otherwise stand far apart, are so drawn together as to form a complete covering; and thus the insects are at once defended from rain and wind, and hidden from their natural enemies.

F. Are these creatures very mischievous?

Mr. E. I will read you an extract from the "Journal of a Naturalist." "Our apple-trees here are greatly injured, and some annually destroyed, by what seems to be a very feeble insect. We call it 'the American blight;' this noxious creature being known in some orchards by the more significant name of 'white blight.' In the spring of the year, a slight hoariness is observed upon the branches of certain species of our orchard fruit. As the season advances this hoariness increases; it becomes cottony, and, towards the middle or end of summer, the under sides of some of the branches are covered with a thick, downy substance, so long as, at times, to be sensibly agitated by the air. Upon examining this substance, we found that it contains a multitude of

small, wingless creatures, which are busily employed in preying upon the limbs of the tree beneath. This they are well able to do, by means of a beak terminating in a fine bristle; this, passing through the bark and the sappy part of the wood, enables the creature to extract, as with a syringe, (or small pump), the sweet vital liquor that circulates in the plant." The sap-wood thus wounded, rises up in lumps; the limb, deprived of its nourishment, grows sickly; the leaves turn yellow, and the part perishes. Branch after branch is thus assailed, until they all become leafless, and the tree dies.

E. Oh! what destructive little creatures! What numbers there must be! Is there no way of checking them, papa?

Mr. E. Some insects, my dear, seem to exist only for the purpose of devouring them; and so great is their voracity, that they are called aphidivorous, or aphis-eating insects. One of these, the larva of a fly called syrphus, is to the aphis what a lion is to a kid. It emits a gluten by which it fixes itself to a spot well stocked with aphides, where it commits havoc like a wolf in a fold: turning its head in all directions, it soon meets with one, which it instantly pierces through with its dart: then placing the body over its mouth like a cork, in a moment the aphis it is sucked dry. Reaumur has seen a piece of stalk seven or eight inches long,

covered with aphides, completely cleared in four days, by *two* or *three* of these creatures.

F. Papa, when I was once with my cousin, Alfred he said, "I'll show you a trick," and he got a piece of straw, and told me I might draw water up through it into my mouth; and so I put one end in a cup of water, and the other into my mouth, and sucked a little, and up it came. Now, papa, I did not know how this was, but now I think I do; did not I draw the air out of the straw, and did not the air press on the water, and so force it up?

Mr. E. Yes, my dear, you are quite right; but I think you understand also something else.

F. I was going to say, papa, that must be the way that all these sucking creatures get what they want.

Mr. E. It is so; but mamma, who has been listening, can think perhaps of some other creatures to whom the same power is very serviceable.

Mrs. E. I'll try, my dear. Only a day or two ago, I was reading, in the account of a voyage, that a sun-fish was taken, and that several sucking-fish* accompanied it, adhering to different parts of the body. One of these singular animals was taken by a spear. It was eleven inches in length, in form resembling a trout, of a brown colour, and without scales. When put into a vessel of water, it immediately fastened itself to the side by its suckers, which

* Echineis remura.—Linn.

are twelve in number, placed in the throat within a flat, oval surface, two inches in length, and barely an inch and a half in breadth.

Mr. E. The Sepia, one of the most remarkable kinds of cuttle-fish, has eight tentaculæ or feet, or, if you please, fingers or arms, besides two feelers, which are much larger than those arms; and at the end of these feelers are strong cups or suckers, in shape somewhat like the cup which holds the acorn. By means of these, the Sepia seizes its prey, and clings to it; and also fastens itself to the ground at the bottom of the sea. In the large feet of some kinds of lizard, the two toes or tighteners may be seen, by which the skin of the foot is pinned down, and the air shut out in the act of walking or climbing; but it is the very same, only upon a larger scale, with the construction of a fly's or butterfly's foot; and by exactly the same power, the weight of the air—does a fly creep on the ceiling, the sea-horse climb the hills of ice, the quicksilver stand in the weather-glass, the piston descend in a pump or the cylinder of a steam-engine, and the wind whistle through a key-hole.

E. Then, papa, air is one of the most wonderful things in the world. Who would have thought you could tell us so much about it, and what is so amusing, too!

Mr. E. As yet we have conversed on only one

of its properties; there are too many to go through them all; but let us notice a few more wonders. Frederick, how should you suppose a bird flies?

F. Perhaps, papa, because, when it has opened its wings, it is lighter than the air.

Mr. E. When its wings are spread, it is indeed better supported by the air, as they cover more of it; but birds are still too heavy to remain in that situation without constantly flapping their wings, as you may have observed when they hover over their nests. If the stroke of the wings be greater than is needed to support the bird, it will rise; if it be less, it will gently fall; as the lark, with its wings open, but motionless, drops quietly into its nest. Here, then, we observe the *resistance* of the air.

F. Why, then, papa, cannot *we* make wings, and soar as birds do?

Mr. E. Because, though we could make wings large enough for the weight of our bodies, we should *not have strength* enough to use them. A quill is, indeed, a little wonder. How strong it is, and yet how light! And how curious are the beards that are fastened to each side of the stem, and form the breadth of the feather; the separate pieces of which are sometimes called filaments, threads, or rays. Here is one; mark how much stronger it is when you rub it flatly than when it is rubbed up and down on the edge; and why, but because it is the broad

surface that has to act against the air, and in which, therefore, the strength is wanted.

E. Dear! I never thought of that; but I shal remember it now whenever I see a quill.

Mr. E. Recollect, too, my love, that these various threads are not loose; they unite, but without glue, or gum, because each of the threads has a vast number of teeth on each side, which hook one into the other, so that when one thread is separated from another by some violence, it may be quickly re-clasped, and thus be always united. Still further, not only is the wing formed of quills which are very curious, but one action of the wing in particular is most remarkable. It is so constructed that such a twist may be given to the great feathers that they may strike the air with their flat side, but rise aslant from the stroke; as the waterman turns the oar, or, as he says, "*feathers* it," when he is rowing. Were it otherwise, though the stroke upon the air by the *under* side of her wing carried the bird up, the stroke from the *upper* side, when she raised her wing again, would bring her down; but by this amazing contrivance of the great Creator—by which she gives the wing a twist—she goes wherever she pleases.

F. Thank you, papa. As you have told us how she *sails*, will you tell us how she *steers*?

Mr. E. Partly by the wings, but principally by the tail. Birds with long legs have short tails, and place

their legs close to their bodies when they fly; at the same time stretching them out behind as far as they can. Thus the legs supply what the tail wants, and become the rudder.—Frederiek, you mentioned a little while ago that what was lighter than the air would rise in it; suppose, then, I tell you something of the *elasticity* of the air, or what we may call its *springiness.*

F. If you please, papa.

Mr. E. Smoke and steam rise upwards, instead of falling, because the air near the earth is heavier than *them,* and thus supports them and forces them to rise; just as a piece of eork floats on the surface of a basin of water, and rises upwards as more water is poured in; except that these vapours do not, like the cork, aseend to the surface; they only rise to that elevation where the air is as light as themselves. Heat, too, expands all bodies; it therefore renders air lighter than that which is cold. In this way a balloon is sometimes made of paper; some tow and spirits of wine are plaeed in a cage at the lower part; these, being lighted, eause the air inside to become lighter than that outside; and hence the "*fire*-balloon," as it is called, ascends in the atmosphere.

Mrs. E. I hope you will be contented, Frederick, without trying to make one. I have known a fire-balloon set a staek of hay or corn on fire. Amusement merely was intended, but mischief arose.

Mr. E. A very good hint, my dear; and it might

have escaped me, for I was thinking of one or two cases in which animals possess a remarkable power of inflation. Thus the chameleon is often for a great while together, entirely flaccid, and is then so lean that the ribs, the vertebræ of the back, and all the tendons of its legs, may be seen and counted very distinctly. In this state, especially when it turns round, it seems a mere animated skin enclosing a few bones; but, by what I may call its *air-pump* within, it is able to increase its general size, to give its lank parts a full and round appearance, and even to double its usual size, the effect of the process extending even into the feet and tail. The inflation continues sometimes during two or three hours. Many other quadrupeds are similarly gifted; and are thus able, it is supposed, to cause the air to pass from their lungs into the interstices, or spaces, betwixt the skin and muscles. The use of the power has not yet been clearly explained. But, Emma, I have another wonder for you yet.

E. O, papa, I hope you have a hundred!

Mr. E. It is that of a well-known fly* which, in its first state, is an aquatic animal, and which sometimes bends its tail so as to form a hollow, then shuts up in it a bubble of air, resembling in brightness silver or pearl, and afterwards sinks with it by its own weight. When it wishes to rise to the surface of the

* Stratiomys chamæleon.

water, it is by means of this bubble, which thus becomes its *air*-balloon. Some fishes have also an air-bladder, to raise them in the water; when it is empty they grovel at the bottom; and those without it, such as flounders, soles, and skates, seldom rise in the water, and then with effort. The rising and sinking of a fish, so far as they do not depend on the fins and tail, can only be regulated by the weight of the body. When, the fish contracts the bladder, as it can, its bulk is also lessened, and the fish descends; but when the muscles are loosened, and the elasticity of the air expands the bladder, it rises; or, if the effort be enough, ascends to the surface.

Mrs. E. Now, papa, give them the story of the water-spider.*

Mr. E. That will be a good close to the present dialogue. She first spins loose threads, and attaches them to the leaves of water-plants; this framework she then varnishes with a gluten, which is like liquid glass; she next lays a coating of the same substance over her own body, and underneath this she puts a bubble of air; but how this is obtained is not exactly known. Clothed with this mantle, which seems formed of shining quicksilver, she plunges to the bottom, skilfully places the bubble of air beneath the roof prepared for its reception, and repeating this ten or twelve times in about a quarter of an hour,

* Aranea aquatica.

she transports air enough to expand her apartment sufficiently, and thus to provide a commodious and dry retreat in the midst of the water. It is about the size and shape of half a pigeon's egg. From this curious chamber the spider hunts, searching sometimes the waters and sometimes the land for her prey, which, when obtained, is taken home and devoured at leisure. About the middle of April the eggs are laid, packed up in a silken cocoon in a corner of the house, and watched by the female with constant care.

E. That is amazing! But what, papa, is the meaning of that hard word, pneumatics?

Mr. E. It is one taken from the Greek word pneuma, which signifies breath, or air; and is used to describe that part of knowledge which relates to what we have been talking about, and to the mechanical properties of air in general. But now for a walk!

> Up! let us to the fields away,
> And breathe the fresh and balmy air;
> The bird is building in the tree,
> The flower has opened to the bee,
> And health, and love, and peace are there!

THE ARCHITECTS.

"Read that passage again, my dear," said Mr. Elwood to his lady. "Mr. Montgomery's poem of the Pelican Island is one of exquisite beauty."

Mrs. Elwood immediately read as follows:—

"The nightingale that dwelt in Adam's bower,
And poured her stream of music through his dreams;
The soaring lark that led the eye of Eve
Into the clouds;
The dove that perched upon the tree of life,
And made her bed among its thickest leaves,
All the wing'd inhabitants of Paradise,
Whose songs were mingled with the songs of angels,
Wove their first nests as curiously and well
As the wood-minstrels of our evil day."

"An interesting fact most delightfully related," said Mr. Elwood; "and now, suppose we close the volume, and converse on others it will not fail to suggest."

"It will be perfectly agreeable to me," replied the lady, "and I can answer for Emma and Frederick, who never seem tired of your accounts of the wonders of nature. What say you, dears?"

E. Mamma, Frederick said, this morning, he meant to be a naturalist, like papa; and I thought, though I said nothing—for he sometimes tells me I talk too much—that I should like to know all about these curious things that a young lady could.

Mr. E. I am glad to hear it. I shall have great pleasure in telling you of them while you are so willing to listen. It has been well remarked, that we may judge by buildings, and other proofs of architectural skill, of the progress of a newly-discovered people in intellect and civilization. If we find them only in rocky caverns, or miserable penthouses of bark, we at once regard them as exceedingly ignorant and debased; if their houses are formed of timber, and thatched with leaves, they rise higher in the scale; but if they enjoy commodious dwellings, disposed regularly into streets, it is obvious they have attained a considerable degree of mental superiority. The conclusion from this, however, is unfavourable to *us*—it shows that the progress of our country has been very slow; for, to go no further back, the description Holingshed gives is deeply humiliating: "There are," he says, "old men yet dwelling in the village where I remain, who have noted three things to be marvellously altered in England within their sound remembrance. One is *the multitude of chimneys* lately erected; whereas, in their young days, there were but *two* or *three,* if so many,

in most uplandish towns of the realm; the religious houses and manor-houses always excepted, and that, peradventure, of some great personage." The other two things to which he alludes, as clearly indicate the same degraded condition. Now, Frederick, can you tell me what is the other conclusion from the fact I have stated?

F. Perhaps, papa, that birds *seem* wiser than we, because their houses were the same at first as they are now.

Mr. E. Just so; their skill is wonderful; and we will now attend to a few specimens of their architecture. In most of the species both the male and female assist in building. They each bring materials to the place: first sticks, moss, or straws, for the foundation and exterior; then hair, wool, or the down of animals or plants, to form a soft and commodious bed for the eggs, and for the bodies of the tender young when hatched. The outsides of the nest bear, in general, so great a resemblance in colour to the surrounding foliage or branches as not easily to be discovered, even by persons who are in search of them.

E. Are the nests alike, papa?

Mr. E. Oh, no! Their variety is great. Some build on the ground, or make a nest in it, which they carefully line; and others rear their dwellings aloft, and form them of very different materials. The

structure of the golden eagle,* for example, is quite flat, without any perceptible hollow, and is commonly built between two rocks, in a dry inaccessible place; the same nest serving for a whole generation. It is constructed nearly like a floor, with sticks five or six feet long, supported at the end and crossed with pliant branches. It is not covered above, but is said to be sheltered by the projection of the upper part of the rock; but this may be only imaginary. One, found in the peak of Derbyshire, was made of great sticks, resting one end on the edge of a rock, the other on two birch-trees. Upon these was a layer of rushes, and over them a layer of heath, and upon the heath rushes again; upon which lay one young one and an addle egg, and by them, a lamb, a hare, and three heath-poults. The nest was about two yards square, and had no hollow in it. The young eagle was of the shape of a gos-hawk; rough-footed, or feathered down to the foot; and having a white ring about the tail.

E. Oh, what a nest! But, mamma, that would not do for a nice *little* bird.

Mrs. E. No, my love; and therefore the little birds build little nests; some of them very pretty and curious indeed; and not a few covered in at the top with a kind of dome. As a contrast to the rude, though substantial fabric just mentioned, I may des-

* Aquila chrysaëta.

cribe to you the most artfully constructed nest of any of our British birds—I mean that of the bottle-tit,* called familiarly, "jack-in-a-bottle," and "bottle-tom;" the nest being formed much after the shape of a bottle. The basis is composed of green mosses, neatly and carefully felted together with fine wool; while the outside consists, for the most part, of white and grey tree lichens, in small bits, intermixed with the egg-nests of spiders, from the size of a pea and upwards, part of which are drawn out to assist in felting;—so that when the texture of the nest is stretched, portions of fine gossamer-like threads appear among the fibres of the wool. Thus the texture of the walls is strong; the inside is soft and warm; and, "in the fore-part," says Aldrovand, "respecting the sun-rise, and that above (where an arched roof, of the same uniform matter and texture as the sides and bottom, covered the nest), was seen a little hole, scarce big enough, one would think, to admit the old one." But papa can tell you of some birds who show how much they love to be together.

Mr. E. The sociable grosbeaks,† as they are called, build their nests in a species of mimosa, or sensitive plant, which grows to a great size, and seems well suited to them, because of its ample head and strong wide-spreading branches, which are well calculated to admit and support the extensive mansion the birds

* Parus caudatus.—Ray. † Loxia socia.

have to erect. In one tree, described by Mr. Paterson, in his travels, there could not be fewer than from eight hundred to a thousand under one *roof*,—so called, because it resembles that of a thatched house, and projects over the entrance below in a very singular manner.

E. Of what do they build their nests, mamma?

Mrs. E. Of a species of fine grass, which is used also for additions and repairs. Sometimes the tree which supports the aërial city gives way to the increase of weight, and the inhabitants have, therefore, to build in other trees. "One of these dissected nests," says Mr. Paterson, "I had the curiosity to break down; and found its internal structure equally as ingenious as the external. There are many entrances; each of which forms a regular street, with nests on both sides, about two inches from each other. From every appearance, the nest I dissected had been inhabited for many years; and some parts were much more complete than others. This, therefore, I conceive, nearly amounts to a proof that the animals added to it at different times, as became necessary, from the increase of the family, or rather of the nation or community."

F. Thank you, mamma, that is a very singular story; do any other birds thus build a little town?

Mr. E. The pigeon-roosts of North America almost surpass belief. Not far from Shelbyville, in the state

of Kentucky, there was one, about five or six years ago, which stretched through the woods, nearly north and south; it was several miles in breadth, and was said to be upwards of forty miles in extent! In this tract almost every tree was furnished with nests, wherever the branches could accommodate them. On some single tree upwards of one hundred nests were found, each containing only a single young one. The noise of the flying and fluttering millions was tremendous. Such an assemblage is altogether without parallel. But let us not forget that every individual nest contains much to excite our admiration of the amazing instinct with which every bird is endowed, and of the boundless goodness by which it was conferred. How, but for this, would a flat or hollow nest be formed at all? Or the outside be made of coarse materials, and the inside of those which are fine and delicate? Or the animals know that they were to have eggs—that these eggs require a nest of peculiar form and size—and that it must be ready exactly at a certain time—and then, that by heat the young will be produced? To me, the architecture of birds, however considered, is full of wonders.

Mrs. E. I perfectly agree with you, my dear: and, if you see no objection, I will now give the children some account of the architecture of the white ants.*

* Termes fatalis.

Mr. E. It will be very appropriate, my love; and they will hearken with great interest.

Mrs. E. The nests of these insects are usually called hills by the natives, as well as strangers, from their outward appearance, which generally resembles the form of a sugar-loaf; and they rise about ten or twelve feet above the ordinary surface of the ground. They continue quite bare till they reach the height of six or eight feet; but, in time, the dead barren clay of which they are formed becomes fertilized, and in the second or third year, the hillock, if not overshaded by trees, becomes like the rest of the earth, almost covered with grass and other plants; and, in the dry season, when the herbage is burnt up by the rays of the sun, it appears not unlike a very large hay-cock. The *exterior* consists of one shell formed in the manner of a dome; large and strong enough to enclose and shelter the *interior* from the changes of the weather, and the inhabitants from the attacks of enemies. M. Malouet, who lately filled a high station in the French government, saw one of these cities, and was informed that it became necessary to destroy the nests by raising a sufficient force to dig a trench all round, and fill it with faggots, which were afterwards set on fire; and then to batter with cannon from a distance, in order to drive the insects out and make them run into the flames. This was in South America; and African travellers have met

with them in the same formidable numbers and strength.

F. So, mamma, the ants are taken by storm, as Seringapatam was, of which I was reading yesterday with papa. But please tell us what is *inside.*

Mrs. E. Ah! that will, indeed, surprise you. In the centre of the building, just under the top, and nearly on a level with the surface of the ground, is the *royal chamber,* not unlike a long oven. Immediately adjoining, and surrounding it on all sides, are the *apartments* for the soldiers and attendants, of whom many thousands always wait on their royal master and mistress. Next to these are the *nurseries,* invariably occupied by the eggs and young ones; and, intermixed with these lie the *magazines,* which are chambers of *clay,* always well stored with the needed provisions. These nurseries and magazines, separated by small empty chambers and galleries, which run round them or communicate from one to the other, are continued, on all sides, to the outer wall of the building, and reach up within it two-thirds or three-fourths of its height, leaving an open space in the middle, under the dome. The passages, or galleries, are of an astonishing size, some being above a foot in diameter, and perfectly cylindrical or round, and are carried under ground to a great distance—sometimes extending more than a hundred yards. These galleries wind spirally to the top of the

hill, like the edge of a corkscrew, and thus the ascent is made more easy. The distance, too, is shortened by another ingenious contrivance; for an arch is frequently made from one spot to another; and one of these, when measured, was found to be ten inches in length, half an inch wide, and one-fourth of an inch thick; and, Smeathman says, it was not *excavated*, or dug out, but *projected*, or thrown over, like the arch of a bridge, from one point to another. What Herculean labours are these! The energies they demand, exceed, it has been said, all the boasted exertions of man. Did these little creatures equal him in size, and were they to retain their usual instinct and activity, their buildings would rise to the astonishing height of more than *half a mile*, and their tunnels would become cylinders of more than *three hundred* feet in diameter; before which the stupendous pyramids of Egypt, and the vast aqueducts of Rome would dwindle into nothing.

Mr. E. It is difficult to find any thing accordant with such mighty works; but I have just been reminded of those portions of the globe,

> "Where, in the furthest deserts of the deep,
> The *coral-worm* its architecture vast
> Uprears, and new-made *islands* have their birth."

The general appearance of coral, I should tell you, is that of a shrub without leaves; the stem being sometimes from three to six inches in diameter, and

;ts whole height being usually from three to four feet. The inside both of the stem and branches is equal to marble in hardness. The polypes, or little animals, which issue from the branches, are white, soft, and semi-transparent. They have eight tentaculæ, or feet, in the centre of which the mouth is situated; and are attached to the walls of their cells only by a very slender ligament, or thread. When coral is taken out of the water, or even touched while under it, all the polypes suddenly contract, and become completely concealed. And yet these little creatures are the builders of islands!

E. Islands!—papa, did you say islands?

Mr. E. Yes, my dear, much as it amazes you, I mean exactly what I say. When Messrs. Tyerman and Bennet were on the island of Huahine, they felt themselves, on one occasion, "at a giddy height," amidst overwhelming grandeur and beauty; and have thus described part of what they saw:—"In the scene beneath, the *coral barrier*, rising from unfathomable darkness, to the warm precincts of the cheerful day, and stretching across the harbour, formed a conspicuous object. On this, the ocean-billows broke in foaming light; while smooth *within*, the bright lagoon lay calm and exquisitely pictured with patches of landscape, shapes of floating clouds, broad paths of sunshine, and clear depths of downward sky reflected from its surface. Our companions told us that, in

their days of ignorance, they believed the long rough coral-reef to be a rib of one of the gods; but how it came there they did not pretend to know. We explained to them, as well as we could, how these marvellous structures are formed, by multitudes on multitudes of the feeblest things that have life, through ages working together, and in succession, one mighty onward purpose of the eternal God; while each poor worm, among the millions which, perhaps, an angel could not count, is merely performing the common functions of its brief existence; and adding, perhaps, but a grain to a mass of materials, which, in process of time, may fill up the bed of the Pacific Ocean, and convert it into a habitable continent. We showed them how thus the motus had been gradually raised above the flood, and become lovely spots of verdure, capable of maintaining both animals and men; producing trees for food and for building; as well as plants to nourish hogs and fowls, or sheep and cattle, such as had been introduced into Eimeo, and might hereafter be bred in all the fertile islands of the Southern hemisphere."

E. But, papa, I do not *quite* see how these little creatures can make an island.

Mr. E. Vast multitudes of them work together, and build nearly in the form of a circle, until they come to the surface of the sea, when they leave off, and go to work somewhere else. The coral-reef,

when just above the level of the water, catches all the mud, weeds, shells, and whatever else may happen to float; and these, by degrees, are covered with mould. Afterwards, the seeds of grass and herbs are caught and grow; the wild-fowl bring more seeds; the soil becomes increasingly abundant; and thus an island is formed. Shrubs, and even young trees, then begin to appear; and, at last, men come from other islands, or the main land. Hundreds of beautiful islands, apparently formed in this way, are scattered through the South Pacific Ocean. How much indebted, then, are multitudes "to the poor and slender coral insect for the construction of these mighty moles, which curb the fury of the mightier deep; and, by their happy interference, have occasioned those fruitful lines of level soil to spread between the hills and floods, which furnish the inhabitants with the principal part both of their food and raiment!"

F. Why, papa, the islanders look *little*, when we think of such wonderful animals.

Mr. E. We saw, some time ago, my dear, that, in some respects, they seem to surpass man; but let us not be mistaken. He learns an art *progressively*, it is true, and they attain their greatest power *at once;* but then, remember, they stop where they begin, while he is always advancing. The coarsest roughest nest may be equal to the hut of a savage, but that savage

may be civilized; he may make for himself a comfortable and elegant dwelling; but the nest of the feathered tenant of the wood, or of the cleft of the rock, will remain for ever the same. Amazing, indeed, are the results of what we call instinct; but it is far surpassed by the noble faculties of the human mind. The exertions of the one are fixed and limited within a small range; but the powers of the other are capable of inconceivable improvement and expansion. This is evident, even now; it will be still more so in eternity.

THE MUSICIANS.

"THAT is a sweet air, Emma, and you have played it better than you have done before; but I do not admire the words; they are like many others I could mention, very silly."

"I think so too, mamma; can you give me some better?"

Mrs. E. I was endeavouring to recollect, love. Oh, I think the goldfinch's song* will just do! I will sing it, and you shall accompany me:—

"I've a snug little nest
In a little elm-tree;
This nest, I am sure,
You'll be pleased when you see.

"It is made with much care,
And is lined so throughout;
It is neatness itself,
Both within and without.

"But a dear little mate,
She with whom I am blest,
Is the neatest of all things
In this little nest.

* Jennings's Ornithologia.

"Should you pass by in May,
When our little ones come,
Look in, and you'll find
We've a snug little home.

"No home like that home
Where two bosoms impart
Their finest of sympathies,
Warm from the heart:

"Where friendship, with love,
Is perpetual guest;
And affection's smooth pillow,
A soft heaving breast."

E. Oh, papa! Is not that beautiful? I dare say mamma will be so kind as to teach it *me;* but I shall never—no never, be able to sing it like her.

Mr. E. That you do not know, love. If, however, you sing as well as you *can,* that is the utmost we can expect. Every little warbler is not a nightingale. But Frederick, I see, has not entered into the song, though his eyes have been fixed on the harp.

F. I was thinking, papa, how the sound was made, and I can't find out; will you please to tell me?

Mr. E. Do you know what a vibration is?

E. Yes, papa; the pendulum of a clock, when it goes from one side to the other, makes a vibration.

Mr. E. Some bodies, then, I wish you to observe—such as a bell, a drum, or musical strings—are called sonorous. Sometimes they owe this to being

elastic. Suppose, now, I draw a string fastened at the two ends, as at A B, to C, it will go forwards to D—this is its first vibration; at the end of this it will retain sufficient force to bring it to E, and back again to F, which makes its second vibration; the third will carry it only to G and H, and so on till the resistance of the air causes it to stop:—

C
E
G
A B
H
F
D

Such a vibration gives a tremulous motion to the air, something like that given to smooth water when a stone is thrown in; first a small round wave is formed, the wave then spreads, and gradually produces similar waves. These waves are formed in the air by touching a musical string, but with this difference, the motion of the air does not consist of regularly extending waves, but of vibrations; and are composed of a motion forwards and backwards. The vibrations of sound go much further too than the waves; for, the air being elastic, the report of a cannon, travelling 1142 feet in a second, may be heard several miles round.

E. Oh! how quick! I was thinking nothing went so fast; but now I recollect that light travels still

quicker. But please tell us a little more about sounds.

Mr. E. If a sonorous body be so struck that its vibrations are performed in regular times, the vibrations of the air will be regular also; and striking regularly on the drum of the ear, we shall have the same uniform sensation on the auditory, or hearing nerve, and the same uniform idea in the mind, or what we call one musical tone. But if the vibrations be irregular, harsh and jarring sounds will be produced, called discords. The quicker the body vibrates, the more acute, or sharp, is the sound. The length of the vibrations depends on the length, thickness, and tightness of the strings; thus bass notes are produced by long, thick, loose strings; and trebles, by short, small, and tight ones. But now I have a puzzle for you. What things are those which are said to be always noisy, and yet always silent?

E. Oh, papa, that is a puzzle! It can't be your violin, or mamma's piano, or my harp; for though they are sometimes silent they are sometimes noisy; and you said they were always *both.*—Ah! it's the *always* that is so perplexing! Let me see; there's—no, that won't do; and—no, nor that!

F. Please, papa, I'll give it up!

Mr. E. No, no! It's worth an effort. But listen while I talk to you about some natural musicians—grasshoppers,* for instance. Some were great

* Cicadæ.

favourites with the ancients, who often kept them in cages for the sake of their song. They were supposed to be perfectly harmless, and to live upon dew. One poet calls the grasshopper "the nightingale of the nymphs;" and another styles it "the sweet prophet of the summer." So attached were the Athenians to some of these insects, that they fastened golden images of them in their hair; addressed them in the most endearing terms; and from this we may gather that their notes were sweet. Indeed, the sound of *them* and of the harp were called by one and the same name. A grasshopper, sitting on a harp, was the usual emblem of music, which was thus explained:—two rival musicians, Eunomus and Ariston, were contending upon that instrument, when a grasshopper flying to the former, and sitting on his harp, supplied the place of a broken string, and secured to him the victory. At Surinam, the music of one species is still supposed to resemble so much the sound of a harp, or lyre, that *there* they are called *harpers*.

E. What a delightful account! *Do*, papa, tell us some more; and I will give you a thousand kisses!

Mr. E. The sounds produced by insects are very various. For example. "That purely rural, little-noticed, and, indeed, local occurrence," says Mr. Knapp, "called by the country people 'hummings in the air,' is annually heard in one or two fields

near my dwelling. About the middle of the day, perhaps from twelve o'clock till two, on a few calm sultry days in July, we occasionally hear, when in particular places, the humming of apparently a large swarm of bees. It is generally in some spacious open spot that this murmuring first arrests our attention. As we move onward the sound becomes fainter, and, by degrees, is no longer audible. That this sound proceeds from a collection of bees, or some such insects, high in the air, there can be no doubt; yet the musicians are invisible. At these times a solitary insect may be observed here and there, occupied in its usual employ; but this straggler takes no part in our aërial orchestra."

Mrs. E. Some insects have obtained for themselves the very names of musicians. The giant cock-roach,* which abounds in old timber houses in the warmer parts of the world, makes a noise when the family are asleep like a pretty smart rapping with the knuckles — three or four sometimes appearing to answer each other; and, on this account, it is called in the West Indies the *drummer.* Gædart says that he has seen and heard a *trumpeter* in the humble-bee's nest, which goes to the top early in the morning, shakes his wings, and sounds his trumpet for a quarter of an hour, thus rousing its inhabitants to work; but this story has been much doubted. It

* Blatta Gigantea.

is, however, not more singular than the following:—while the labourers of the white ants are building, one places himself close to the wall, and seems to act as overseer of the works. Every now and then he makes a particular noise, by lifting up his head and striking with his mandibles, or jaws, upon the wall of the nest, which is answered by a loud hiss from all the labourers, and appears to be a signal for dispatch; for, every time it is heard, they may be seen to quicken their pace, and to work with greater diligence. But, papa can, perhaps, recollect some others.

Mr. E. A remarkable genus of Gryllidæ* are silent in the day, but, in the evening, they make a tremulous and tolerably loud noise, which is sometimes heard on every side. The species of this genus ought to be called *fiddlers*, since their sound is produced by passing the hind legs over a number of short raised ridges on the abdomen, which may be called their *fiddle-strings*. But no sound has a more extraordinary effect than that which is produced in a hive.

E. How I should like you to describe it! I love every thing about bees.

Mr. E. Were a new queen allowed to leave her cell as soon as she could, the workers would have much trouble to prevent her destroying her rivals;

* Pneumira.

and hence she is not suffered to come forth till she is quite ready for her flight. When, at length, she is permitted to do so, if she approaches the other royal cells, the workers on guard seem very angry, and pull, bite, and chase her away. Sometimes, standing in a commanding attitude, she utters a peculiar sound, which is a very distinct kind of clicking, composed of many notes in the same key, which rapidly follow each other; and this so much affects the bees that they all hang down their heads, and remain motionless; and whenever she has recourse to this position and sound the effect is the same. At length, a swarm leaves the hive, when she either precedes or follows.—But have you found out my riddle?

E. Oh, no, papa! I cannot tell what is *always* noisy and *always* silent. Have you, Frederick?

F. No, Emma; if it is always noisy, how can it be silent; and if it's always silent, how can it be noisy? I shall never guess, I'm sure! Tell us, papa, *do* tell us!

Mr. E. No insect, like larger animals, uses its *mouth* for utterance of any kind; and hence it has been said, that, notwithstanding the variety of their sounds, they are perfectly mute.

E. Oh! I see, I see! But then, how are the sounds produced?

Mr. E. By different means. The grasshopper, for

instance, has, as Swammerdam says, "two peculiar small drums, like the drum of our ear, which, being struck by two cartilages, or gristly substances, vibrate the air in such a manner as to produce the sound." Of some such insect the Greek poet Anacreon said:—

> Happy creature! What below
> Can live more happily than thou?
> Seated on thy leafy throne,
> (Summer wears thy verdant crown,)
> Little tales thou lov'st to sing,
> Tales of mirth—an infant king!

E. And now, dear papa, suppose you were to tell us about the pretty birds. How delightfully some of them sing! Surely they are excellent musicians!

Mr. E. I was just about to do so. Among them many musicians may certainly be found,

> ———————— whose notes
> Nice-fingered art must emulate in vain.

I remember, however, reading of a very singular parrot, purchased at Bristol for one hundred guineas, which whistled a variety of tunes, answered many questions, and also repeated a great number of sentences. It is said to have beaten time with all the appearance of science; and so accurate was its judgment, that if, by chance, it mistook a note, it would go back to the bar where the mistake was made, correct itself, and, still beating regular time, go through the whole with wonderful exactness. It

died in 1802, and, on being dissected, the muscles which regulate the voice appeared from practice uncommonly strong.

E. Well! That was very, *very* strange!

Mr. E. Now, mamma, suppose you tell them about the lark.

Mrs. E.

> "————— ————— Up springs the lark,
> Shrill-voic'd and loud, the messenger of morn;
> Ere yet the shadows fly, he, mounted, sings
> Amid the dawning clouds; and from their haunts
> Calls up the tuneful nations."

Yes! on first leaving the earth his notes are feeble and interrupted; but, as he rises, they gradually swell to their full tone. He is a songster whom all should love; the peaceful, verdant landscape heightens the effect of his melody; and in winter, when all is dreary, desolate, and cheerless, he cannot sing. But let us not forget that—

> ——— Philomel is ours; and in our shades,
> Through the soft silence of the list'ning night,
> The sober-suited songstress trills her lay.

E. And who is Philomel, mamma?

Mrs. E. The nightingale, love; one of the most exquisite of singing-birds. Mr. Barrington once kept a very fine one for three years; and listened attentively to its song. Its tone was not only very mellow, but most brilliant. When it sang its song round, in

its whole compass, he observed sixteen different beginnings and closes, while the notes between were varied with so much judgment as to produce a most delightful effect. Its song, too, continued sometimes for not less than twenty seconds without a pause; and, whenever the songstress took breath, she did so as carefully and wisely as possible.

F. I read the other day something about the mocking-bird;* it was but little; perhaps, dear papa, you know more about it than I can find in any of my books, and Emma, I am sure, will be surprised when she hears what a curious creature it is.

Mr. E. It has been called "the prince of all song-birds;" not only because its voice is unusually extensive and varied, but because it has the singular power of imitating the notes of *all* other birds. Pennant says that he heard one in a cage imitate even the mewing of a cat, and the creaking of a sign in the high winds.

E. What a strange little fellow! And then so musical, too!

Mr. E. Yes; his voice is capable of almost every modulation, from the clear mellow tones of the wood-thrush to the savage scream of the bald eagle. In measure and accents he faithfully follows those he imitates, but he far surpasses them in force and sweetness of expression. In his native woods, on

* Turdus polyglottus.

a dewy morning, his song rises above every competitor; and while singing, he opens his wings and his tail, glistening with white, keeping time to his own music; and the animation of his eye, and the buoyant gaiety of his action, are no less fascinating than his song. He sweeps round with extacy, mounts as his song rises, descends as it dies away, and sometimes bounds aloft with the swiftness of an arrow. So perfect are his imitations, that a bystander might suppose all the feathered tribes had assembled together on a trial of skill, and each was striving to produce its utmost effect.

E. Papa, do you remember any of his imitations?

Mr. E. He whistles for the dog; Cæsar starts up, wags his tail, and runs to meet his master. He cries like a hurt chicken, and the hen hurries out, with feathers on end, to protect her injured brood. He goes over the notes of the canary and of the red-bird, in so superior a style, that the silence of the mortified songsters confess his triumph. He often deceives the sportsman, and even birds themselves are frequently imposed on by this admirable mimic. The hunters, in their night excursions, know that the moon is rising the moment they begin to hear his delightful solo, and, during moonlight, he sings the whole night long.

F. Papa, are birds *born* with their different songs?

Mr. E. No; the peculiar notes of the different species are altogether acquired, as language is by us; and the attempt of a nestling to sing is like that of your little brother Edward to talk. A common sparrow, though in a wild state it would only have chirped, was once taken from the nest when very young, and placed near a linnet and a goldfinch, and it adopted a song formed of the notes of these two. And this is only one proof among many.

Mrs. E. It shows too, my dears, how important good instruction is. The child left to itself, will have all its bad passions unrestrained; but, if properly taught, we may hope to see it greatly improved. I know a little boy and girl who *ought* to be very good.

E. and F. I do—I do, mamma!

Mr. E. I hope, then, you will be so. Now, Emma, for some of the kisses you promised me.

THE GEOMETRICIANS.

Mr. E. Emma and Frederick, come here.

E. Yes, papa; have you found something pretty to show us?

Mr. E. Look there;—what do you see?

E. Only a spider, papa, and I don't like spiders.

Mr. E. And why not, Emma?

E. Why, papa, because — because — because — I don't.

Mr. E. That's a little girl's reason indeed, Emma; but I dare say it is as good a one as you have. I want to show you and Frederick what a curious creature a spider is; and that its movements should awaken interest, not dread or disgust.

F. I am sure, papa, Emma and I will be very glad to listen. I never liked spiders; but what you tell us about such creatures is so entertaining, that now we are always looking out to see what we can find, and, perhaps, a cobweb is as wonderful as a bird's nest.

Mr. E. Now, first, look at the spider itself. There are many kinds; but all present, in general form, a

strong family likeness. The body is divided into two parts:—the fore-part, containing the head and breast, is separated from the hind-part by a very slender thread, and, together with the feet, is covered with strong scales; the hind-part is clothed in a very fine and supple skin, which is covered with hair. It has generally eight fine eyes in different parts of the head, covered with a hard, polished, and transparent crust; and, as they are immoveable, they have been multiplied, to convey to them whatever it is important they should know. The fore-part of the head has two stings, or rather branches with strong points, like a couple of saws, and ending in a nail like the claw of a cat; near the point of which is a small opening, through which the poison issues. These branches, truly formidable to their foes, they open and extend at pleasure; but, when no longer wanted, each of its nails is bent down on its branch, like a pruning-knife clasped upon its handle. The spider has eight legs, like those of a crab; and at the end of each three crooked and moveable claws are fixed: that is to say, a small one placed in the side, like a spur, by the aid of which they fasten themselves to their thread—and two others of a larger size. The inner curve of these is indented, and they enable the insects to fix wherever they please, and to slide about, by grasping whatever comes in their way.

F. Has the spider any arms?

Mr. E. They have two legs in the fore-part of the body, which may be called their arms; since they are only used for holding and turning the prey. But, although the spider has these weapons, it wants an ambuscade to surprise its victim; since it has no wings to aid its pursuit, while its prey has these means of escape. Hence, it is provided with a stock of material, which it can spin into a thread to form a web, or snare; this it spreads in the open air to catch the prey. Instinct points out the proper season: for the web is not begun till the flies appear, and, when the snare is finished, the insect goes behind it, waiting patiently for a victim, from which it is hidden.

E. That's singular, however. But, papa, the spider we are looking at* is making its web; will you tell us how it is done?

Mr. E. All spiders have at the under-part of the extremity of the body four or six spinners, each of which has a multitude of tubes or pipes, so numerous and so very fine that, Reaumur says, a space, not much bigger than the pointed end of a pin, has *a thousand* of them. At about one tenth of an inch from the point of the spinners, the threads which issue from them unite, and form the one we see, of which the spider makes his web; and which, fine as it is, is, in fact, a rope, composed of, at least, *four thousand*

* Aranea domestica.

fibres, or strands. The openings of the spinners are closed at pleasure; and thus the insect, when dropping from its height by a line, may stop whenever it chooses. Various places are selected for the web; but this spider, you perceive, has chosen a spot where prey always abounds. It has, however, found this recess to secure itself a passage of escape from any threatened danger. Having done so, the spider presses its spinners against one of the sides, and glues to it one end of the thread. It proceeds from one side, as far as the place to which it intends to stretch its web, while the thread lengthens in the rear. The thread is fastened to one of the spurs or claws of the spider's feet, lest it should touch a wall or other obstruction, and when the insect has reached the point on the opposite side, to which it intends to continue the web, it there fastens this first thread by means of glue; and, pulling the thread, it renders it tight. Close by this thread another is fixed, which it carries forward by running along the first, like a tumbler on his rope. The second thread is glued on one side of the point where the work was begun. The first two threads are used like a scaffold to assist in building all the rest. All the threads are stretched and fastened, one after another, with equal art and industry, and the whole is done with wonderful expedition.

F. Are all the threads exactly alike, papa?

Mr. E. No; those intended for the outer part or selvage of the web want more strength, and are, therefore, made three or four times as strong, by repeating what I have just described. From these, others are spun in various directions; the insterstices are filled up by threads spun by the spider as it runs from one to the other, until the whole is finished.

E. Now, papa, I do think all these movements very ingenious.

Mr. E. They are so, my love; but the garden-spider is still more clever;—I will tell you something about him. He is called a *geometric* spider, because he seems acquainted with *geometry*, or the science of figure; the name of which is derived from two Greek words, which signify the measure of the earth—land-measuring having first turned the attention of men to it. He, however, must have designed forms and marked out distances long before them. But, Frederick, what are radii?

F. A radius, papa, is a line drawn from the centre of a circle to the outer line or circumference; radii is the plural of radius, and radii are, I now remember, like spokes to a coach-wheel.

Mr. E. Very well. As the spider's web is usually fixed either in an upright or slanting direction, in an opening between the leaves of some shrub or plant, it is obvious that round its whole extent lines will be required to which those ends of the radii may be

attached that are furthest from the centre. These then are made first, the spider being careless about the shape of the space enclosed, aware that she can make a circle as readily in a triangle as in a square. To make them strong, she forms each line of five or six, or even more, threads glued together; and, to keep them properly tight, she fixes a great number of smaller threads to them from different points. Having thus completed the foundations of her snare, and attached a thread to one of the main lines, she walks along it, guiding it with one of her hind-feet that it may not touch in any part and be glued too soon, and crosses over to the opposite side where she firmly fixes it. To the middle of this thread, which is to form the centre of her net, she fixes a second, which, in like manner, she conveys and fastens to another part of the lines encircling the space. While this is doing, she proceeds slowly, as if it required consideration; but she now proceeds rapidly, for no sooner are the marginal lines of her net firmly stretched, and two or three radii spun from its centre, than the eye can scarcely follow her progress. Twenty radii, giving the net the appearance of a wheel, are speedily finished. She then proceeds to the centre, quickly turns herself round, and pulls each thread with her feet to try its strength, breaking any one that seems defective, and replacing it by another. Next she glues immediately round the centre

five or six small concentric circles, like so many rings of different sizes one within the other, distant about half a line, or the fifth of an inch, from each other; and then four or five larger ones, each separated by a space of half an inch or more. These last serve as a sort of temporary scaffolding to walk over, and to keep the radii properly stretched while she glues to them the concentric circles that remain; which she now proceeds to construct. Placing herself at the circumference, and fastening her thread to the end of one of the radii, she walks up that one towards the centre, to such a distance as to draw the thread from her body of a sufficient length to reach to the next. Then stepping across, and conducting the thread with one of her hind-feet, she glues it with her spinners to the point in the adjoining radius, to which it is to be fixed; and thus she goes on until she has filled up nearly the whole space with circles, distant about two lines, or two-tenths of an inch, from each other. She always, however, leaves a vacancy round the smallest first-spun circles that are nearest to the centre, but why is not known. Lastly, she runs to the centre and bites away the small cotton-like tuft that united all the radii, which now being held together by the circular threads, have thus, probably, their elasticity increased; and, in the circular opening thus made, she takes her station and watches for her prey.

E. And what is this spider called, papa?

Mr. E. It is the Epeira Diadema, or common garden-spider. The largest web with which we are acquainted is, however, that of the labyrinthic spider,* which may often be seen spread out like a broad sheet in hedges, furze, and other low bushes, and sometimes on the ground. The middle of this sheet, which is of a close texture, is swung, like a sailor's hammock, by silken ropes extended all around to the higher branches; but the whole curves upwards and backwards, sloping down to a long funnel-shaped gallery, which is nearly horizontal at the entrance, but soon winds obliquely till it becomes quite perpendicular. This curved gallery is about a quarter of an inch in diameter, is much more closely woven than the sheet part of the web, and sometimes descends into a hole in the ground; though oftener into a group of crowded twigs, or a tuft of grass. Here the spider dwells securely, frequently resting with her legs extended from the entrance of the gallery, ready to spring out upon whatever insect may fall into her sheet-net. She herself can only be caught by getting behind her and forcing her out into the web. What should you think, Emma, of *cleaning* one of these delicate and tender dwellings?

E. Why, papa, I should suppose that it could not be done. But do you really mean *cleaned*, or do you mean to joke and look slyly at us, as you do sometimes?

* Agelena labyrinthica.

Mr. E. I am quite serious. Spiders are very cleanly. When we look at the material they use, and at the rough, hairy, covering (with a few exceptions) of their bodies, it might be supposed they would always be stuck over with particles of the fibres which they produce; but they are very careful to prevent this, and seldom, if ever, leave a thread to float at random, except when they wish to form a bridge. Whenever a spider drops along a line to try the strength of her web, or the nature of the place beneath, she always, on re-ascending, coils it up into a little ball and throws it away. Whatever particles of web or of dust are caught by the hairs of the legs, are not suffered to remain long. A spider which appears to a careless spectator as resting idly, will be found, in nine cases out of ten, slowly combing her legs with her mandibles, which, like her claws, are furnished with teeth, beginning as high as possible on the thigh, and passing down to the claws. The flue combed off is regularly tossed away.

E. Now, papa, that is very tidy, certainly; but how does she keep her web clean?

Mr. E. A modern writer on natural history* tells us that he was coming down the Maine, by the steam-boat, from Frankfort, in 1829, and thus describes what he saw. "We observed the geometric net of a conic-spider†

* J Rennie, Esq. † Epeira conica.

on the frame-work of the deck, and as it was covered with flakes of soot from the smoke of the engine, we were surprised to see a spider at work on it; for, in order to be useful, this sort of net must be clean Upon observing it a little closely, however, we perceived that she was not constructing a net, but dressing up an old one; though not, we must think, to save trouble, so much as an expenditure of material. Some of the lines she dexterously stripped of the flakes of soot adhering to them; but in the greater number, finding that she could not get them sufficiently clean, she broke them quite off, rolled them up, and tossed them over. We counted five of these packets of rubbish which she thus threw away, though there must have been many more, as it was some time before we discovered the manœuvre, the packets being so small as not to be readily perceived, except when placed between the eye and the light. When she had cleared off all the sooted lines, she began to replace them in the usual way; but the arrival of the boat at Mentz put an end to our observations."

E. Well! *That* is astonishing. I find, papa, these little disagreeable creatures, as I once thought them, are really very interesting. Can you tell us any thing else?

Mr. E. Spiders, it is said, have been domesticated. Eight hundred were once kept and fed in one apartment by a Parisian manufacturer, and they became so

tame, that whenever he came in with his dish of flies, they came down to take their food. A Frenchman too, of the name of Pelisson, being imprisoned in the Bastile, had no pen, ink, or paper, nor any company, but that of a stupid creature, whose only occupation was playing on a bagpipe. A spider made its web at the edge of the window which lighted the prison and, to relieve his solitude, Pelisson undertook to tame it, by placing flies in its way, while his companion played on his instrument. By degrees the spider became accustomed to the sound, and ran from its hole to receive its prey. Always summoned by the same sound, and having its food placed gradually at a farther distance from the web, the insect, in a few months, became so well disciplined, that, at the first signal, it would leave its hiding-place, and come and take its flies at the bottom of the chamber, under Pelisson's eyes. But I must just mention some other geometricians.

F. As companions, papa, to the geometric spider.

Mr. E. Just so. If, for instance, you wish to have a room built up with closets or little cells, all of the same size and shape, geometry teaches that there are only three figures which will answer, so that no space may be lost between the cells: they must either be squares, or figures of three equal sides, or figures of six equal sides. This can be most satisfactorily proved. The six-sided figure is by far the most convenient of these

three shapes, because its corners are flatter, and any round body placed in it has, therefore, more space, there being less room lost in the corners. Moreover, this figure is the strongest of the three; any pressure either from without or within will hurt it less, as it has something of the strength of an arch. A round figure would be still stronger, but then room would be lost between the circles; whereas none at all is lost in the six-sided figure. Now it is a most remarkable fact, that *bees build their cells exactly in this shape*, and thereby save room and materials beyond what they could if they built in any other shape whatever. Nor is this all, the roof and floor are as admirably arranged. It is proved by geometricians that to give the greatest strength and save most room, the roof and floor must be made of three square planes meeting in a point; and further, that *there is one particular angle*, or inclination of these planes to each other where they meet, which makes a greater saving of materials and work than any other whatever could possibly do. And just so do the bees invariably make the tops and bottoms of their cells. Who would have dreamed of these little creatures being wiser than Sir Isaac Newton? And yet such is the fact. Of what I have now stated that illustrious man was ignorant: it was only found out by one of his most celebrated followers. Thus they work with a truth and correctness which are quite perfect, and according to the

principles at which man has only arrived after ages of slow improvement in the most difficult branch of the most difficult science. "But the mighty and all-wise Creator, who made the insect and the philosopher, bestowing reason on the latter, and giving the former to work without it—to Him all truths are known from all eternity, in a manner that mocks even the conceptions of the sagest of human kind."

THE CARPENTERS.

"How delightful is the evening breeze! The rich perfume of the clover-blossoms mingles with that of the new-mown hay. And, look!—this hedge offers its tribute; for here the dog-rose and the honey-suckle give out their sweetness. And there is melody too. Hark! how the blackbirds and thrushes enjoy themselves!—Stop!—There is a nightingale, so greatly esteemed for the excellence of its song; the notes of which, it is supposed, may be heard above half a mile, when the evening is calm.

"Now, let us proceed. What fine specimens of the ash!—one of the most valuable of trees. It has been known for ages; agrees with a great variety of situations and soils; and the quicker it grows, the more valuable it is. It is called 'the husbandman's tree;' for nothing is so fit for agricultural implements. Every part, at every season, seems of value: the thinnings of young plantations, and the suckers from the roots of grown trees, or from the stocks of trees cut down, are very serviceable,—the leaves, and even the twigs, are eaten eagerly by cattle,—the bark is

useful in tanning—and the wood yields, when burned, a considerable quantity of potash. See! how it carries its principal stem higher than the oak, and the looseness of the leaves corresponds with the lightness of the spray.

"The mountain-ash is a different tree; it is exceedingly hardy, grows any where, but is seldom planted as a timber-tree. Its white flowers, and its bright red berries, make it ornamental in a shrubbery; and, intermingled with the dark pine and waving birch, it casts a solemn gloom over the northern hills. Always in season, the light green tint of its leaves, in summer, happily contrasts with the deeper green of the surrounding trees; and, in autumn, its glowing berries sparkle amidst the dark brown cones of the larch and the spruce.

"But we have reached the wood. What a peaceful community of oaks, elms, and beeches! How pleasant are these walks, so gratefully shaded by trees! See the hollys and hawthorn beneath! Every now and then those pretty cottages with their blooming gardens and orchards peep out; while that aged woman, resting on her stick, and tottering along with her hand on her hip,—and the girl bearing the pail of foaming milk on her head,—and those robust and healthy men, women, and children, give life to the picture.

"What a splendid row of oaks! That noble tree

rears its head amidst the storm, and is more deeply rooted for its rage. None, except the cedar of Lebanon, is so remarkable for the stoutness of its limbs; they do not exactly spring from the trunk, but divide from it, so that it is sometimes difficult to distinguish the branch from the stem. Its twisted branches add greatly to its beauty; and its wide-spreading boughs proclaim it the monarch of the trees.

"Hark! what is that noise? We'll turn aside and see. It is as I guessed. We heard the strokes of the woodman's axe. See, what havock he has made! Some fine trees lie on the turf; a few bare trunks are stripped ready to be borne away; others still have their noble branches waiting for the spoiler. Look at his children, pulling off the bark, and picking up the chips. All may do something.

"But see, he goes to yonder elm. He plies it with his axe—he uses his saw;—now he has cut far through the trunk;—see, he drives a wedge;—now another and another;—the branches tremble—the trunk cracks—the tree quivers—reels—and falls!

"And now," continued Mr. Elwood, who had thus been pointing out objects of interest to his family in their walk, "who can tell to how many uses it will be applied, when, having been cut into planks by the sawyer, it is given up to the carpenter?"

"No one, I presume,"' replied his lady; "but, by

the way, what an interesting conversation we might have about *'the carpenters;'* I have thought of them before, but did not mention them; suppose then, as it will be too late when we return this evening, we talk about them to-morrow morning. What say you, dears?"

"I should like it very much," said Frederick. "And so should I too," said Emma.

As soon, therefore, as the breakfast things were removed next morning, Emma exclaimed:—"I am sure I did not know what you meant last night, mamma, when you proposed that we should talk about the carpenters; though I was sure it was something very amusing and instructive, because what you and papa tell us is always so. And I can't tell now. I know Sam Turner, who comes every now and then, with his old broken hat, and his long dirty apron, and his saw, and plane, and hammer, and a great parcel of things in a basket, to put up a shelf, or to open a lock; but you can't mean him, or such as he; and I never heard of any other carpenters. But, dear!—I might have thought of that before—perhaps some insects are called so."

Mr. E. Yes, my dear, and other creatures too; but we'll begin. The goat-moth caterpillar,* which abounds in Kent and many other places, feeds on the wood of willows, oaks, poplars, and other trees; and,

* Cossus ligniperda.

if it does not find a hollow large enough to contain its body in a bent position, it *scoops out* one in the tree before winter comes. One of these creatures, described by a naturalist, not content with the bare walls of its cell, made a lining for it of the raspings of the wood it had scooped out, and of the strong silk it had spun, which was as thick as coarse broad-cloth, and equally warm. On being removed from its winter abode, and placed under a glass, along with some pieces of wood, which it might eat, if it pleased, it began to move about; and it was not long in forming a cell as ingenious as the former. It made a retreat for itself, exactly like the one which it had left, formed of raspings of wood taken from what had been given it for food; the largest piece serving as a covering and protection for the whole. It remained there motionless, and without food, till the spring; when it gnawed its way out, and began to eat most voraciously.

E. But, papa, he could not make up for the time he had lost!

Mr. E. No. But for this there was no necessity. In May, it made a second cell greatly superior to the first. Others were lately observed in the trunk of a poplar, but only in the part which was stripped of its bark. The ingenuity of these creatures appeared in scooping their cells almost to the very surface of the wood, leaving only an outward covering, as thin as writing-paper. More than one

chrysalis was seen breaking through this covering, within which there was a round moveable lid, of a sort of brown wax. The larva of the puss-moth* makes a cell of bark. And there is a little creature† to be found on the oak, which selects a smooth young branch, measures out the space wanted with its body for a rule, and then forms a very curious building, the walls of which are much like the feathers of an arrow; and the whole can scarcely be distinguished from the branch, being formed of the same materials, and having therefore the same colour and gloss.

E. And so, papa, these are some of the little carpenters. But, though I did not know till now there were any, yet, I should think, they are not all.

Mr. E. No, my dear; nor shall I be able to mention all; there are several kinds; and I and mamma will tell you of a few of each. Perhaps, my dear, you will give them an account of the carpenter-ants.

Mrs. E. With pleasure. The emmet, or jet-ant,‡ so called from its shining black colour, may sometimes be met with in hedges, and in the trunks of decayed oak, or willow-trees. The labourers always work in the inside of trees, and are desirous of doing so in secret. On one side of their buildings, Huber found horizontal galleries, hidden in great part by their walls; and on another parallel galleries, separated by very

* Cerura vinula. † Pyralis strigulalis. ‡ Formica fuliginosa.

thin partitions; having no communication, except by a few oval openings. In other fragments of their edifices (for he could never get them to work under his inspection), he found avenues, which opened sideways, including parts of walls and partitions, erected here and there within the galleries, so as to form separate chambers. When the work is further advanced, pillars are cut out in the same wall, and are worked into regular columns. In some cases, these same partitions, pierced in every part and hewn skilfully, are made into colonnades, which support the upper stairs, and leave a free communication throughout the whole. To the building they give an extreme degree of lightness. "I have seen," says Huber, "fragments, from eight to ten inches in length, and of equal height, formed of wood as thin as paper, containing a number of apartments, and presenting the most singular appearance. At the entrance of them, worked out with so much care, are very considerable openings; but in place of chambers and extensive galleries, the layers of the wood are hewn in arcades, allowing the ants a free passage in every direction. These may be considered the gates, or vestibules, conducting to the several lodges."

F. How clever that is! Are there any other ants that are so skilful?

Mrs. E. Yes; and some have the ingenuity to mix up the chips, which they chisel out, with spider's web,

and thus to make a material of which to form entire chambers.

E. Mamma, what tools can they have for all this? A man cannot work without *them.* When Sam Turner was here the other day, and I told him Edward's barrow was broke, he said he could not mend it, for he *hadn't* his tools.

Mrs. E. Their only tools, like those of bees and wasps, are their mandibles; and thus they have two advantages over Sam Turner: they are never troubled by their weight; and they cannot regret, when out, that they have left them at home. Besides, what would he say, could you give him one tool which could do every thing? And yet this is their case.

F. Papa, are any bees famous in this way?

Mr. E. There is one,* almost as large as the humble bee, not so downy, but more deeply coloured, which, when spring comes, shuns the sappy and green wood, which is probably too tough for its purpose, and seeks for some old post or withered part of a tree, to begin its house. It will not, however, select any wood placed in a spot where the sun rarely shines. As soon as a piece of that which is dry and rotten is found, it begins to bore it; and, having gone to a certain depth, changes the direction of the cavity;—a work which occupies it for some weeks. For days

* Xylocopa violacea.

together, the carpenter-bee may be seen going in and out of its hole, and shovelling out the saw-dust which it has produced. The cavity is from twelve to fifteen inches long, and often broad enough to admit a man's forefinger. A single bee will make two or three of these holes in a season.

E. And what is all this labour for, papa?

Mr. E. The cavity is divided into about twelve parts, each intended to receive an egg. The lowest part forms the basis of the first recess, where the insect piles up bee-bread about an inch in height; on the top of this one egg is laid, and over the whole a roof is formed, which serves as a cover to the bottom chamber, and a floor for the second which is above. Each partition is about as thick as a crown-piece; and the making of it is very curious. The bee begins by glueing the particles of saw-dust round the *outside* of the cavity, so as to make a ring; *inside* this, she glues more; and thus she gradually works from the outside to the centre; and at last, a covering of circles of saw-dust, one within the other, is formed.

F. Does she make more cells than one?

Mr. E. Yes; she proceeds as she did at first, until the whole space is filled up with cells. The shape and size of each she knows well, and even the exact quantity of food which the grub will eat, from the moment of its birth to its maturity; and hence she places this in its abode.

E. How does it carry food to the nest?

Mr. E. Reaumur says, "I observed several of these insects walking in the little forest which surrounds the flower of the poppy; by their bulk and weight they upset and pressed down all the filaments or threads which crossed their path; during their progress their hind-legs became covered with pollen, or yellow dust, which adhered to the downy hairs on their surface; and after they had buried themselves in several flowers successively, each of the last pair of legs appeared as if it had on a footless boot." With this load the insect flew to the nest, rubbed off the pollen, which, mixed and tempered with honey, was then laid up in the cell.

F. What becomes of the saw-dust, papa?

Mr. E. Shovelled out by the bee, it falls on the ground, and forms a little heap near the wood in which the insect is at work; and when it wants materials to form partitions, it goes to the heap, and bears away grain after grain until its task is completed. And now, I will ask you a question. From the order of the eggs, the worms in the different cells are of different ages, and, consequently, the lowest comes out first. Now, tell me, how can it get out? Does it wait till those above have escaped?

E. Ah! papa, you want to puzzle us. And I am sure you do. Look at Frederick, with his hand on

his forehead, and his eyes on the ground; he can't tell, that's plain; and as for me, I have been trying, but I can't imagine. But you know that, for if I could it would have been out in a minute.

Mr. E. I will, then, unriddle the riddle. The grubs are placed with their *heads downwards*, and the mother-bee makes a hole at the bottom of the cavity communicating with the lowest cell, and through this back-door the insect goes out. When the food in the next cell is eaten, its inhabitant gnaws away its under partition, and then, through the cell which has just been left, passes out the same way. All this is, indeed, most amazing. What labour do we here witness! An insect bores a cavity fifteen or twenty times its own height, carries out the saw-dust, and then collects from this heap, grain by grain, a sufficient quantity to part off as many nurseries as its young may require; and all this is done by an instinct both admirable and astonishing. Be it ours, then, my children,

"To trace, in Nature's most minute design,
The signature and stamp of power divine.
The Invisible in things scarce seen revealed,
To whom an atom is an ample field;
To wonder at a thousand insect forms,
These hatched and those resuscitated worms,
New life ordained, and brighter scenes to share,
Once prone on earth, now buoyant upon air,

Whose shape would make them, had they bulk and size,
More hideous foes than fancy can devise;
With helmet heads, and dragon-scales adorned,
The mighty myriads, now securely scorned,
Would mock the majesty of man's high birth,
Despise his bulwarks, and unpeople earth."

E. Oh, papa, I hope you are not going to stop! I could listen to you and mamma all day. Please try, and recollect some more wonderful little things.

Mr. E. I meant, my love, that you should hear about birds; and I am glad you are so desirous for me to proceed. The ancient Peruvians called all that chisel out holes in trees by a name literally rendered carpenters by the Spaniards, and one of them, the woodpecker, mamma will describe.

Mrs. E. The woodpecker is well prepared for its labours. It lives chiefly on insects, lodged in the bodies of decayed or decaying trees. For the purpose of boring into the wood, it has a bill, straight, hard, angular, and sharp. When, by means of this, it has reached the cells of the insects, then comes the office of its tongue, which is, *first*, so long that the bird can dart it out three or four inches from the bill—in this respect differing greatly from every other species of bird; *secondly*, it is tipped with a stiff, sharp, bony thorn; and, *thirdly*, which seems the most remarkable property of all, this tip is dentated, or toothed on both sides, like the beard of an arrow, or the barb of a

hook. So strong is the bill of the black woodpecker* that it can pierce hard trees, such as the oak and hornbeam. The hole it makes is enlarged within for the greater convenience of depositing its nest. The noise made by the white-billed woodpecker† against the trees of the wood is very great; and when several are at work together, the sound is not much unlike that proceeding from woodmen or carpenters. A bushel of chips—a proof of the labours of this bird—is often to be found at the foot of the tree. On examination, the holes it makes have generally been found of a winding form, the better to protect the nest from the effects of the weather. Of the downy woodpecker,‡ Wilson gives the following lively account, which I will read to you:—

"About the middle of May, the male and female look out for a suitable place for the reception of their eggs and young. An apple, pear, or cherry-tree, often in the neighbourhood of the farm-house, is generally pitched upon for this purpose. The tree is minutely reconnoitred for several days previous to the operation, and the work is first begun by the male, who cuts out a hole in the solid wood, as circular as if described by a pair of compasses. He is occasionally relieved by the female, both parties working with the most indefatigable diligence. The

* Picus Martius. † Picus Principalis. ‡ Picus Pubescens.

direction of the hole, if made in the body of the tree, is generally downwards, by an angle of thirty or forty degrees, for the distance of six or eight inches, and then straight down for ten or twelve more—within, roomy, capacious, and as smooth as if polished by the cabinet-maker; but the entrance is judiciously left just so large as to admit the body of the owner. During this labour they regularly carry out the chips, often strewing them at a distance, to prevent suspicion. This operation sometimes occupies the chief part of a week. The female, before she begins to lay, often visits the place, passes out and in, examines every part both of the exterior and interior with great attention, as every prudent tenant of a new house ought to do, and at length takes complete possession. The eggs are generally six, pure white, and laid on the smooth bottom of the cavity."

Mr. E. In the habits and manners of the different species of nut-hatch * there is a very close alliance to those of woodpeckers. Its food is various, and it has a singular way of getting at the kernel of nuts. The squirrel rasps off the small end, splits the shell in two with his long fore-teeth, as a man does with his knife; the field-mouse nibbles a hole with his teeth, as regular as if drilled, and yet so small that one would wonder how the kernel could be extracted

* Sitta Europea.

through it; but the nut-hatch picks an irregular ragged hole with his bill, and as he has no paws to hold it while he pierces it, he, like an adroit workman, fixes it, as it were, in a vice, in some cleft of a tree, or in some crevice, when, standing over it, he perforates the stubborn shell. Now, Frederick, read us the account I will show you of one of these birds, accidentally wounded by a sportsman, and which, being taken, was placed in a small cage of plain oak-wood and wire; it is a striking proof of energy and fatal perseverance.

F.—(Reads.)—"Here he remained all night, and the next morning his knocking or tapping with his beak was the first sound I heard, though sleeping in an apartment divided from the other by a landing-place. He had food given to him—minced chicken and bread crumbs, and water. He ate and drank with a most perfect impudence, and the moment he had satisfied himself, turned again to his work of battering the frame of his cage, the sound from which, both in loudness and prolongation of noise, is only to be compared to the efforts of a fashionable footman upon a fashionable door in a fashionable square. He had a particular fancy for the extremities of the corner pillars of his cage; on these he spent his most elaborate taps; and at this moment, though he has only occupied the cage a day, the wood is pierced and worn like a piece of old worm-eaten

timber. He, probably, had an idea that if these main beams could once be penetrated, the rest of the superstructure would fall and free him. Against the door-way he had also a particular spite, and once succeeded in opening it; and when it was tied in a double knot with string, the perpetual application of his beak quickly unloosed it. In ordinary cages a circular hole is left in the wire for the bird to insert his head to drink from a glass; to this hole the nuthatch constantly repaired, not for the purpose of drinking, but to try to push out more of his head, but in vain, for he is a thick bird, and rather heavily built; but the instant he found the hole too small he would withdraw his head, and begin to dig and hammer at the circle, and where it is rooted in the wood, with his pickaxe of a beak, evidently with a design to enlarge the orifice. His labour was incessant, and he ate as largely as he worked, and I fear it was the united effects of both that killed him. His hammering was peculiarly laborious, for he did not perch as other birds do, but grasping his hold with his immense feet, he turned upon them as upon a pivot, and struck with the whole weight of his body, thus assuming the appearance, with his entire form, of the head of a hammer, or as I have sometimes seen birds on mechanical clocks made to strike the hour by swinging on a wheel. We were in hopes that when the sun went down he would cease from

his labours and rest; but no, at the interval of every ten minutes, up to nine or ten o'clock in the night, he resumed his knocking, and strongly reminded us of the coffin-maker's gloomy occupation. It was said by one of us, 'He is nailing his own coffin,' and so it proved. An awful fluttering in the cage, now covered with a handkerchief, announced that something was wrong; we found him at the bottom of his prison with his feathers ruffled, and nearly all turned back. He was taken out, and for some time he lingered, and at length drew his last gasp."

E. Poor fellow! why did he work so hard?

Mrs. E. Another remarkable fact, which occurred at Chelmsford in 1807, places the carpentry of birds in a very striking light. An elm was cut down, and, upon being sawed into planks, a hollow was discovered *near the centre of the tree,* containing a bird's nest and several eggs, which were unfortunately broken by the saw. How long it had lain in this recess cannot be known; but, as the yolks of the eggs were not dried up, one would suppose that it could not be a very long period; though it is not apparent how any part of an elm, naturally a slow-growing tree, should increase so rapidly as to enclose the nest and eggs before the latter were destroyed by moisture and insects, particularly as the cavity in question was *covered with five or six inches of solid wood.* The probability is, therefore, that here was

the work of some bird, to whose power we have seen much is practicable.

E. Thank you, dear papa and mamma; as I see you cannot stay longer with us, Frederick and I will talk about what you have been saying, and see how much we can remember about the carpenters.

THE CONSTITUTIONALISTS.

FREDERICK thought his parents were about to relate what would interest himself and his sister when they had come in from their walk, and he was delighted when he was sure it was so; and as for Emma, she instantly laid down the flowers she had gathered—O, such a bunch of shepherd's-purse, fox-glove, adder's-tongue, blue-bell, and cuckoo-flower, and a host beside!—and looked more pleased than she did when she found the prettiest of them springing up wildly in the field, or breathing fragrance from the midst of the hedge.

"The poet has declared, my dears," said their father, as soon as they were seated, "that '*Order* is heaven's first law;' and certainly it is essential to peace and happiness. It is necessary in a family, and is also required in a kingdom. The constitution, or mode of government, in Britain, has many great and peculiar advantages, of which you will hear much when you are older; but I now wish to relate some curious facts as to the order or government of inferior creatures, to whom I propose to give the name of

constitutionalists. The Walrus* is an immense marine animal, sometimes measuring nearly eighteen feet in length, and ten or twelve feet in circumference; and immense herds of these creatures, have often been seen floating on masses of ice. There they lie huddled together like swine, but even among *them* some kind of order seems to be maintained, for the whole herd are never found asleep, but *some are always on the watch.* Monkeys usually live in extensive troops, and it has been said by some writers—whom, however, I consider *too credulous*—that they form a sort of republic, in which great subordination is kept up; that they always travel in good order, conducted by chiefs, the strongest and most experienced animals of their troop; and that on these occasions some of the largest monkeys are likewise placed in the rear, the sound of whose voice immediately silences those who happen to be noisy.

Mrs. E. The land-crab† of the Bahama Islands is also very remarkable. These animals live as a family, or orderly society, and march to the sea-side, regularly, about April or May, in a body of some millions. At the proper season, they sally out from the stumps of hollow trees, the clefts of rocks, and the holes which they dig for themselves in the earth. When on the march, the ground is covered with them, so that a step can scarcely be taken without treading on them. They

* Trichecus rosmarus. † Cancer ruricola.

take the shortest course to the sea; neither turn to the right hand nor to the left; and, if even a house stands in the way, they will attempt to scale the walls. The procession from the mountains is generally formed of three divisions. The first consists of the strongest and boldest males, that, like pioneers, clear the way, and face the greatest dangers. These are often obliged to halt for want of rain, and seek the most convenient retirement, till a change of weather enables them to go forward. The main body is composed of females, which never leave the mountains till the rainy season is begun. They march in regular order, being formed into columns fifty paces broad and three miles long, and so close that they almost cover the ground. In a few days this party is followed by a parcel of stragglers, male and female, that are not so strong as those which have advanced before them. They travel chiefly in the night; but if a shower falls in the day, they do not fail to avail themselves of it. After a journey of several weeks is concluded, they reach the shore, deposit their spawn, throw off their shells, gain new ones, and, as soon as they are sufficiently hard, set out on their return.

Mr. E. Birds of certain species, also, change their abode at a set time of the year, and migrate, as it is called, to climates better suited to them and their young than those they leave. Many British birds

retire to the southern parts of Africa before the commencement of the cold season, and return again in the spring. They generally go in large companies; and in the day-time follow a leader, who is occasionally changed. Many tribes make a continual cry during the night, in order to keep together. Thus they

> "Ranged in figure, wedge their way, and urge
> Their airy caravan; high over seas
> Flying, and over lands, with mutual wing
> Easing their flight."

Mrs. E. Many insects, too, seem to be under the influence of the social principle; for, as Wordsworth has said—

> "Nor wanting here to entertain the thought,
> Creatures that in communities exist,
> Less, as might seem, for general guardianship,
> Or through dependence upon mutual aid,
> Than by participation of delight
> And a strict love of fellowship combined.
> What other spirit can it be that prompts
> The gilded summer-flies to mix and weave
> Their sports together in the solar beam,
> Or in the gloom and twilight hive their joy?"

Some insects thus unite to feed, march, or labour; and of what are called *imperfect societies,* I will give you an example in the history of the gold-tail-moth.* As soon as one of the young caterpillars comes from

* Porthesia chrysorrhæa.

the egg, it begins to feed; another quickly joins it, placing itself by its side; and thus they proceed till a row of them is formed across the leaf. A second is then began; and, after this is completed, a third: and so they go on till all the upper surface of the leaf is covered; but as a single leaf will not contain the whole family, the remainder take their station on the adjoining ones. As soon as they have satisfied the cravings of hunger, they begin to think of erecting a common habitation, which, at first, is only a vaulted web, to cover the leaf they inhabit; but which, by their united labours, in due time grows into a magnificent tent of silk, containing various apartments, sufficient to defend and shelter them all from the attack of enemies and the inclemency of the seasons. As these caterpillars, like eastern monarchs, are too delicate to put their feet upon the rough bark of the tree upon which they feed, they lay a silken carpet over every road and pathway leading to their palace, which extends as far as they have occasion to go for food. To this habitation they retreat when the sun is too hot, and during heavy rains; they likewise pass part of the night in them; and, indeed, some may generally be found at home. On any sudden alarm they retreat to them for safety, and also when they cast their skins; in the winter they are wholly confined to them, coming forth again in the spring; but in May and June they entirely desert them, and,

losing all their love for society, live in solitude till they become pupæ, which takes place in about a month.

E. Are there many in a family, papa?

Mr. E. The family of the processionary bombyx,* a native of France, and which inhabits the oak, consists of from 600 to 800 individuals. When young, they have no fixed abode, but encamp in different places under shelter of their web; but when they are two-thirds grown, they weave for themselves a common tent. About sun-set, the regiment leaves its quarters; and at its head is a chief, by whose movements the procession is regulated. When *he* stops all stop, and proceed when he proceeds; three or four of his immediate followers succeed in the same line, the head of the second touching the tail of the first; then comes an equal series of pairs, next of threes, and so on as far as fifteen or twenty. The whole procession moves regularly on with an even pace, each file treading on the steps of those that precede it. If the leader, arriving at a particular point, pursues a different course, all march to that point before they turn. Probably they are guided by some scent given to the tracks by those who pass over them. Sometimes the order of procession is different; the leader, who moves singly, is followed by two, these are succeeded by three, then come

* Cnethocampa processionea.

four, and so on. When the leader—who in nothing differs from the rest, and is probably the caterpillar nearest to the entrance of the nest, followed as I have described—has proceeded to about the distance of two feet, he makes a halt; during which those which remain come forth, take their places, the company forms into files, the march is resumed, and all follow as regularly as if they kept time to music. These larvæ may occasionally be seen at mid-day out of their nests, packed close one to another, without making any movement; so that, though they occupy an ample space, it is not easy to discover them. At other times, instead of being laid side by side, they are heaped one upon another, as if they were interwoven together. Thus, also, they are disposed in their nests. Sometimes the families divide into two bands, which never afterwards unite. But here comes dear mamma, who, with her usual kindness, will tell you, I doubt not, some striking facts as to what are called *perfect societies* of insects.

Mrs. E. With the greatest pleasure. The government of the termites, or white ants, should be first noticed. In each community there appears to be four different descriptions of these insects:—*workers*, or larvæ, who erect and repair the buildings, collect provisions, attend the females, convey the eggs to what are called the nurseries, and feed the young larvæ till they are old enough to take care of themselves;

nymphs, or pupæ, which differ in nothing from the larvæ, except that they have rudiments of wings, or rather the wings folded up in cases; *soldiers,* of which there is but one for every hundred of workers, and distinguished by their being nearly fifteen times as large, and having a formidable pair of awl-shaped, jagged mandibles, as hard as a crab's claw, and capable of inflicting a painful wound, whose part is to guard the colony, and defend it from attack; and *males* and *females,* which are exempt from all labour, and are furnished with wings for the purpose of migrating to establish new colonies. Each colony, however, possesses only one male and female, which are, it appears, *elected* after taking wing.

F. I should *so* like to know how they form a colony.

Mr. E. In the evening, when the rains are about to come, at the end of the dry season, these insects, having reached their perfect state, in which they have two pair of wings, leave their clay-built citadels in multitudes to seek their fortune. Carried by the wind, they fill the air, entering the houses, extinguishing the light, and are even driven on board the ships which are not far from the shore. The next morning they cover the surface of the earth and waters, deprived of the wings which before enabled them to avoid their numerous foes, and which are only intended to carry them a few hours, and looking

like large maggots; instead of creatures the most active, industrious, and rapacious, they are now become the most helpless and cowardly beings in nature, and the prey of innumerable enemies, to the smallest of which they make not the least resistance; so that scarcely a single pair in many millions get into a place of safety, and lay the foundation of a new community.

E. But mamma said they *elected* a male and female; pray how do they manage that?

Mrs. E. The workers, who are constantly prowling about, occasionally meet with one of these pairs, and, being impelled by instinct, pay them homage, and they are elected, as it were, to be king and queen, or rather father and mother, of the colony. All that are not so fortunate perish; and, considering the host of their enemies, probably during the following day. The workers, as soon as the election takes place, begin to enclose their new rulers in a small chamber of clay, suited to their size, the entrances to which are only large enough to admit themselves and the neuters, but much too small for the royal pair to pass through; so that their state is one of confinement, which continues to the end of their existence.

E. Mamma, if our queen were to be served so, who would like to be one? I should not, I'm sure; I'd rather walk about as I liked; and it would be better for Frederick to be a worker or a soldier than

such a king. But how pleasant it is for us to be a little boy and girl; and how delightful to have so kind a mother and father, who are *not* ants, and are never shut up in a cell!

Mr. E. The queen sometimes lays sixty eggs in a minute, or eighty thousand and upwards in twenty-four hours. What a number must they produce, then, when they live for two years! How busy, too, must the workers be! The nurseries, it should be remarked, are always covered with a sort of mould, amongst which many little globes arise about the size of a small pin's head, which are supposed to be the food of the larvæ. In addition to the workers attending the royal chamber, there is a body-guard to the pair that inhabit it, and the surrounding apartments always contain many workers and soldiers in waiting, that they may assist and defend those on whose safety depends the happiness and even existence of the whole community.

F. And, papa, are there no other sovereigns and subjects you and mamma can tell us of?

Mrs. E. When papa conversed with you about the paper-makers, he showed how the mother-wasp became the foundress of a colony. In a community of social wasps* or humble bees,† each one seems to do what he pleases. The male wasps, however, are not idle, like those among ants and hive-bees; they do

* Vespa vulgaris. † Bombus terrestris.

not, indeed, seek building-materials or provisions, nor take any concern in nursing; but the younger Huber says they act as the scavengers of the nest, by sweeping the floors of the terraces and passages leading to them, carrying off all kinds of rubbish, as well as the bodies of those which die. When a burden is too heavy for one, two unite in the task, and it is sometimes divided. It was discovered by a boy that wasps seem to appoint sentinels at the entrance of their nest to give alarm in case of danger, and that no other intimations are attended to. For, if the sentinels be taken away and destroyed, nothing will induce the wasps arriving from the fields to attack an intruder; but, if one escape from within, it immediately proclaims war, and is apparently charged to avenge the invasion, and prepared in so doing to sacrifice its life.

Mr. E. A hive of bees is essentially monarchical—that is, you know, it must have a sovereign; and when more than one queen is produced, a deadly strife ensues, and they destroy one another. The first of the royal pupæ that is transformed attacks the rest, and stings them to death; though were they covered in complete cocoons, this could not be done, for the sting could not penetrate the silk, or, should it, the barbs would stick fast in the meshes, and the royal assailant perish from her own fury. She can only destroy her rivals as the hinder rings remain

uncovered; and, on this account, it is supposed the royal larvæ spin only *imperfect cocoons*, open behind, and covering only the head, shoulders, and first ring of the abdomen. Of this Huber was satisfied from the experiments he made.

Mr. E. The government maintained by the reigning queen is, indeed, most singular; but in future conversations we will notice other striking facts respecting it. Not less extraordinary, however, were the exhibitions given by Mr. Wildman of the power he had acquired over these creatures. He possessed a secret by which he could, at any time, cause a hive of bees to swarm upon his head, shoulders, or body, in a most surprising manner. He has been seen to drink a glass of wine with the bees all over his head and face more than an inch deep; several fell into the glass, but did not sting him. He could even act the part of a general with them, by marshalling them in battle-array upon a large table. There he divided them into regiments, battalions, and companies, according to military discipline, waiting only for his word of command. The moment he uttered the word *March!* they began to move in a very regular manner, in rank and file like soldiers; and to these, his Liliputians, he taught so much politeness, that they never attempted to sting any of the numerous company which, at different times, resorted to witness and admire this singular spectacle.

Mrs. E. His exploits have been thus celebrated in verse:—

"Such was the spell which, round a Wildman's arm,
Twined in dark wreaths the fascinated swarm,
Bright o'er his breast the glittering legions led,
Or with a living garland bound his head.
His dexterous hand, with firm yet hurtless hold,
Could seize the chief, known by her scales of gold,
Prune, 'mid the wandering throng, her filmy wing,
Or o'er her folds the silken fetter fling."

He found, by long experience, that when he turned up a hive, and gave some taps on the sides and bottom, the queen immediately appeared. Accustomed to see her, she was recognized at once, and, by practice, he could seize her instantly with a tenderness which did not in the least endanger her person. Possessed of her, he could slip her into his other hand, and, returning the hive to its place, hold her, till the bees were all on the wing, and in the utmost confusion. By placing the queen in view, he could make them alight wherever he pleased—for instance, on his head, and even hang from his chin like a living beard, from which he would order them to his hand, or to a neighbouring window.

E. And how did he make them do these astonishing things?

Mrs. E. His own words will furnish a reply. A liberated Roman slave being accused of witchcraft,

because his crops were more abundant than those of his neighbours, produced as his witnesses some superior implements of husbandry, and well-fed oxen, and, pointing to them, said, "These, Romans, are my instruments of witchcraft; but I cannot show you my toil, my perseverance, and my anxious cares." "So," says Wildman, "may I say, These, Britons, are my instruments of witchcraft; but I cannot show you my hours of attention to this subject, my anxiety and care for these useful insects; nor can I communicate to you my experience acquired during a course of years." But who is this now coming up the path? I see, my dears, it is your aunt Melville, and your cousins Alfred and Sarah; let us go and give them a welcome.

HYDROSTATICS.

"It rains so heavily," said Mr. Elwood, "that we cannot go out as we intended; we will therefore content ourselves at home; and, as some compensation for your disappointment, my dears, mamma and I will explain to you the cause of these descending showers.

"The atmosphere, be it observed, is less dense as it is more distant from the earth; and therefore the vapour which the sun causes to ascend—not only from seas, rivers, and lakes, but from the moisture on the land—rises till it reaches that region of air which is of the same gravity or weight as itself; and *there*, of course, it remains stationary. As fresh vapour is added, large bodies of it are gradually formed; these we call *clouds*; and when they become too heavy for the air to support, they fall to the ground. The descent, however, is wonderfully curious; for, as this takes place, several of the watery particles are attracted by others, and thus unite in the form of a drop of water. The vapour, therefore, changed into a shower, is heavier than any part of the atmosphere, and, consequently, falls to the earth.

F. Papa, I remember you told us many things about the weight of air; and I now see that we have rain because of *the weight of water.* Can you tell us any thing more about it?

Mr. E. I will try, my dear; mamma, I doubt not, will assist my recollection. Whatever is lighter than water will, you know, swim upon the surface; and *there* we may often observe little animated creatures sporting with delight. I will read you a passage from "The Journal of a Naturalist:"—"Water, quiet, still water, affords a place of action to a very amusing little fellow,* which, about the month of April, if the weather be tolerably mild, we see gamboling upon the surface of the sheltered pool; and every schoolboy, who has angled for minnows in the brook, is well acquainted with this merry swimmer in his shining black jacket. Retiring in the autumn, and reposing all the winter in the mud at the bottom of the pond, it awakens in the spring, rises to the surface, and commences its summer sports. They associate in small parties of ten or a dozen, near the bank, where some little projection forms a bay, or renders the water particularly tranquil; and here they will circle round each other, without contention, each in his sphere, and with no apparent object, from morning until night, with great sprightliness and animation: and so lightly do they move on the

* Gyrinus Natator.

fluid as to form only some faint and transient circles on its surface. Very fond of society, we seldom see them alone, or, if parted by accident, they soon rejoin their busy companions. One pool commonly affords space for the amusement of several parties; yet they do not unite, or contend, but perform their cheerful circlings in separate family associations. If we interfere with their merriment, they seem greatly alarmed, disperse, or dive to the bottom, where their fears shortly subside, as we soon see again our little merry friends gamboling as before." Kirby says, "Covered with lucid armour, when the sun shines they look like little dancing masses of silver, or brilliant pearls." De Geer mentions a small larva, which is to be found at all seasons of the year, the depth of winter excepted, in stagnant waters. When it is disposed to feed, it lifts its head, and places it horizontally on the surface of the water, so that it forms a right angle with the rest of the body, which always remains perpendicular to the surface. It then sets in motion, with great rapidity, *two brushes* formed of hairs, and fixed in the front of the head, which make a current towards its mouth, and hence it has its meal of the various animalcules which come within the vortex thus produced.

Mrs. E. These animalculæ, my dears, are the smallest animated creatures with which we are acquainted; and yet, as I hope to show you one day

in a microscope, wonderfully constructed. The common wheel animalcule* appears to the naked eye only like a yellowish dot, and is so called from having a pair of instruments on the front part of its body, which, in figure and motion, are something like wheels. It may be kept for several months out of water, and in a state of perfect dryness, without losing the principle of life. When dry, it is of a globular form, and about the size of a grain of sand. If put into water, a languid motion begins after the space of about half an hour; it then turns itself about, lengthens by degrees, and soon afterwards becomes very lively. In a short time its wheel appears, and it swims about in search of food, or else, fixing itself by the tail, obtains its food by its rotatory organs, which throw the fluid into a violent commotion. While it is in action, it frequently changes its shape and appearance, and the head, which before was very taper, sometimes becomes, almost instantaneously, as broad as any part of the body. The circular organs, which whirl round with great velocity, are very transparent, and are thrown out from tubular cases, into which the animal can withdraw them at pleasure. They sometimes turn the same way, and, sometimes, different ways at the same time. How amazingly curious, then, is its machinery!

Mr. E. La Martiniere has given us a description

* Vorticella rotatoria.

of the bubble volvox,* a most singular animalcule, scarcely visible to the naked eye. Speaking of the species, he says, "They consist only of oval bodies, similar in shape to soap-bubbles, arranged in parties of three, five, six, and nine; among them are also some solitary ones. These collections of globules, being put into a glass filled with sea-water, described a rapid circle round the glass by a common movement, to which each one contributed by simply compressing the sides of its body. I endeavoured to persuade myself," he continues, "that I was about to witness one of the most wonderful phenomena of nature, supposing that these molecules, which were now employed in increasing or diminishing their number, or performing their evolutions in the glass, would soon assume the form of a new animal, of which they were the living materials. My impatience led me to detach two from the most numerous group, imagining that this number might be more favourable to the expected metamorphosis. I was, however, mistaken. These I examined with more attention than the rest, and the following account is of their proceedings alone. Like two strong and active wrestlers, they immediately rushed together, and attacked each other on every side; sometimes one would dive, leaving its adversary at the surface of the water; one would describe a circular movement, while the other

* Volvox bulla.

remained at rest in the centre: their motions at length became so rapid, as no longer to allow me to distinguish the one from the other. Having quitted them for a short time, I found them on my return re-united as before, and amicably moving round the edge of the glass by their common exertions.

E. It is strange indeed, papa, that these little creatures, scarcely to be seen, should play such gambols on the water; but, as great things move on it, such as boats and ships, is not the water *very* heavy?

Mr. E. To answer your question satisfactorily, my dear, I must enter more fully on the science of *Hydrostatics*, on which, in fact, we have already been conversing. It treats of the pressure of watery or liquid fluids; and its name is derived from two Greek words, which signify *the stopping or balancing of water.*

F. O papa, I should *so* like you to do that!

Mr. E. Hydrostatics has to do, in part, with what is called *the specific gravity* of bodies; and this means simply the weight of one body compared with that of another of the same size. When we say that lead and stones are heavy, and that paper and feathers are light, we speak comparatively; hence some body is required as a standard by which things may be determined to be light or heavy; and the one that is adopted for this purpose is *distilled water.* With this, then, a great many bodies have been compared, and their specific gravity marked on a scale; so that it may be seen at

once whether they are heavier or lighter. Those, however, who wish to judge in any case for themselves, employ a little instrument called a *hydrometer;* and by this they find, among other things, whether spirits, such as brandy, have been adulterated, or had water mixed with them. As milk, too, is in a certain degree heavier than water, it will instantly tell if water has been added to it. Accordingly, in Switzerland and the north of Italy, where all the peasants bring their milk every evening to a common dairy; and, having it measured each time, are allowed a portion of cheese at the end of the season, according to the quantity of milk mentioned in the books as theirs, a hydrometer is used to detect any mixture of water, which would make the milk lighter.

E. Papa, all you are saying is quite *new* to me I am so glad you thought of it; and I *sha'n't* mind when it rains again, if you will tell us what is so pleasing.

Mrs. E. It is a singular fact, but some little creatures seem to have a notion of the specific gravity of different bodies. Were you desirous of examining them, if you placed yourself beside a clear and shallow pool of water, you would observe at the bottom, little oblong moving masses, like pieces of straw, wood, or even stone. These are the larvæ, well known to fishermen by the name of *caddis-worms,** and which,

* Trichoptera.

when taken out of the water, are found to inhabit cases very singularly formed. Of the larva itself, nothing can be seen but the head and legs, by means of which it moves itself in the water, and drags after it the case in which the rest of the body is enclosed, and into which it wholly retires on any alarm. One forms a pretty case of leaves glued together lengthways, but leaving an opening sufficiently large for the inhabitant to put out its head and shoulders when it wishes to look about for food. Another uses pieces of reed, grass, straw, wood, &c., cut into convenient lengths, carefully joining and cementing each piece to its fellow as the work proceeds; and he frequently finishes the whole by adding a broad piece, longer than the rest, to shade his door-way overhead, so that he may not be seen from above. Another * weaves together a group of the leaves of aquatic plants into a roundish ball, and, in the middle of this, forms a cell. Others form houses, which may be called alive, making them of the shells of snails † and muscles, even while inhabited—a covering, as Kirby says, "as singular as if a savage, instead of clothing himself with squirrel-skins, should sew together into a coat the animals themselves."

F. But, mamma, I should think they would be sometimes too light, and at others too heavy.

Mrs. E. Most admirable is the provision to meet this difficulty. Not being able to swim, but only to

* Phryganea. † Planorbis.

walk at the bottom of the water, by means of the six legs attached to the fore-part of its body, and the insect itself being heavier than water, it is of great importance that its house should neither incommode it in walking by its buoyancy or weight, and that it should be so equally *ballasted* in every part as to be very readily moveable. Hence caddis-worms always choose the most suitable substances; *if the cell be too heavy, they glue to it a bit of leaf or straw; or, if too light, a shell or piece of gravel.*

Mr. E. That is very remarkable. But hydrostatics has to do with *the pressure of fluids* as well as with the specific gravity of bodies; and it is worthy of observation that fluids *press equally in all directions.* If, for instance, a piece of soft wax, of an irregular figure, and an egg be placed in a bladder, or in a bottle of India rubber, filled with water; then if the bladder be laid in a strong box, and a cover be put upon it, so as to be entirely supported by the bladder, and any large weight be laid on the cover, yet, although it shall amount to three or four hundred pounds, the wax will not change its shape, nor will the egg be broken, notwithstanding they must each have sustained a pressure equal to that enormous weight. It is evident, too, that the pressure exerted in particular instances may be overcome. Thus there is a bird called "the diver,"* whose structure is wonderfully

* Colymbus glacialis.

adapted to its mode of life. The head is sharp, and smaller than the adjoining part of the neck, in order that it may pierce the water; while, in addition to other peculiarities, the feet are broad for swimming; yet so folded up, when advanced forward to take a fresh stroke, as to be full as narrow as the shank. Several hundred small vessels are employed in the fishery for pearls, which are dived for to the bottom of the sea. A stone of eighteen or twenty pounds' weight is tied by a cord to the great toes of the persons called divers; a cord is then fastened under their arms, and held by the persons in the boat. Each of them is also furnished with a sack, that has the mouth distended by a hoop: on reaching the bottom, they slip off the stone, fill the sack with shells which contain the pearls, and, on giving a signal, are drawn up with the treasure which they find adhering to the coral-banks.

F. Do they go very deep, papa?

Mr. E. The depth of the water is twenty or thirty yards, and the distance from the shore is four or five leagues. They rest for about eight or ten minutes between each plunge, and continue their slavish employment for ten or twelve hours a day. I may mention also the curious invention of the diving-bell, which is a large iron vessel, let down into the sea, in which masons, bricklayers, and carpenters, may work under water, if they have to lay the foundation

of a lighthouse or harbour, or to save property after a wreck. To show you how it acts, observe this basin which I have nearly filled with water; I now take this glass, which is called a beaker, or tumbler, and turning it upside down, I lower it, evenly and gently, into the basin, and push it fairly down to the bottom; but you will see that no water enters the glass, because it contains air; and, until *that* is removed, water cannot get in. Now put your hand on the glass, and you will find it requires considerable force to keep it down, because of the upward pressure of the water. Raise one side of the glass, and you will observe some bubbles which are produced by the air escaping; but only as this takes place can the water enter.

E. How long do they stay in the diving-bell at the bottom of the sea, papa?

Mr. E. They can remain a long time, my dear; for, as it is necessary that the men should be supplied with fresh air, a communication is kept up with the surface by means of two leathern tubes; down one of which the air is forced by a machine which acts like a bellows, while that which has become impure by breathing, escapes up the other.

Mrs. E. A body, which has sunk to the bottom of the water, may be made to rise by various means. The diving bird and the diving man both know how to re-ascend. A water-beetle,* also, may be seen to

* Dytiscus marginalis.

rise to the surface in order to take in fresh air; it seems to have a silver bubble suspended to it, by which it ascends in consequence of its being specifically lighter than water; though when it descends, or moves horizontally, it is by regular and successive strokes of its swimming legs. The argonaut, or paper nautilus,* whose shell is nearly circular, and six or eight inches in breadth, of a white or yellowish colour, and but little thicker than paper, having a keel, or ridge, slightly toothed on each side, appears, however, in some degree *scientific*. Whenever it means to sail, *it discharges a quantity of water from its shell*, by which means it becomes lighter than the surrounding water, and, of course, rises to the surface. Here it extends two of its arms upwards; these have at their extremity an oval membrane which serves for a sail; while the other six arms hang over the sides of the shell, and supply the place of oars and a rudder. Hence a poet says:—

> "Two feet they upward raise, and steady keep;
> These are the masts and rigging of the ship.
> A membrane stretched between supplies the sail,
> Bends from the masts, and swells before the gale.
> The other feet hang paddling on each side,
> And serve for oars to row and helm to guide.
> 'Tis thus they sail, pleased with the wanton game,
> The fish, the sailor, and the ship the same.
> But, when the swimmers dread some danger near,
> The sportive pleasure yields to stronger fear:

* Argonaut argo.

No more they wanton drive before the blasts,
But strike the sails, and bring down all the masts.
The rolling waves their sinking shells o'erflow,
And dash them down again to sands below."

In some places, when the sea is not agitated by winds, great numbers of them may occasionally be seen diverting themselves by sailing about in this manner: but as soon as a storm or any disturbance arises, they retract their arms, *take in as much water as renders them heavier than that in which they swim*, and thus sink to the bottom.

Mr. E. Other interesting cases have occurred to me of the pressure of water. What must that be which is exerted by the great fall of Niagara? I will read you part of the fine description of it given by Mr. Howison, in his "Sketches of Canada." "I was now within the area of a semicircle of cataracts, more than three thousand feet in extent; and floated on the surface of a gulf, raging, fathomless, and interminable. Majestic cliffs, splendid rainbows, lofty trees, and columns of spray, were the gorgeous decorations of this theatre of wonders; while a dazzling sun shed refulgent glories upon every part of the scene. Surrounded with clouds of vapour, and stunned into a state of confusion and terror by the hideous noise, I looked upward to the height of one hundred and fifty feet, and saw vast floods, dense, awful, and stupendous, vehemently bursting over the

precipice, and rolling down, as if the windows of heaven were opened to pour another deluge upon the earth." Another writer tells us that the fall discharges 670,255 tons in a minute; and I mention it not only as an extraordinary fact, but for the purpose of bringing another before you more strikingly, namely, that *any quantity of water,* however small, may be so distributed as *to balance any quantity of water, however great.*

E. Oh, papa, I should have thuoght that quite impossible!

Mr. E. So would many persons, my dear; but experiment places it beyond all doubt. The effect produced depends upon the *height* and *the surface* of the fluid, and *not upon its bulk;* and thus a very small quantity of water may do great mischief, if it happens to be applied or distributed so as to stand high, in however thin a body or column; and to spread over a wide but confined and shallow space. Thus a very small pipe of water, twenty feet long, was found to burst a hogshead with great violence. The same process in nature may produce extensive devastations; it may cause earthquakes, and split or heave up mountains. This marvellous power has often been used; and there has been a most ingenious and valuable application of it, by Mr. Bramah, in what is called the *hydrostatic press,* by which a prodigious force is exerted; so that a man, with a

machine the size of a common tea-pot standing before him on a table, may eut though a thiek bar of iron as easily as he eould clip a pieee of pasteboard with a pair of shears!

F. I am quite astonished, papa; *that* is one of the most wonderful things I ever heard!

Mrs. E. We shall often find, if we properly use our *eyes* and our *minds* that art is only an application of some natural principle; we have seen one this morning acted upon by what is called instinet; and I have just thought of a singular ease in whieh man has invented what aeeounts for a curious faet in inanimate nature. When you have been in London, my dears, you may have observed some distillers' men drawing off spirits from a puncheon, by means of a long tube, called *a syphon.* The handle of papa's walking-stick, you know, is eurved; and if you suppose it to be drawn out so as to make a long part and a short one, you will have a good idea of the shape of that instrument. Now, the short part is put into the cask, and, as a little pipe is placed very near the extremity of the long one, the man sucks the air out of the syphon by means of *this,* and then the pressure of the atmosphere *on* the liquor in the cask, forees it up the syphon; so that it runs through it into a vessel plaeed to receive it. As long as the tube continues full, no air can gain admittance; the liquor will therefore flow on till it is

stopped by means of a tap provided for the purpose, or till the vessel is emptied.

E. But, mamma, what has this to do with nature?

Mrs. E. Some springs of water are called *intermitting*, that is, they run for a time and then stop, and, after a time, run again and then stop; and, in some places, the most absurd tales have been told respecting them; and designing men have imposed on the credulity of others by pretending to foretel the return of the spring after it had ceased, or engaging to stop it when it was running. But their folly may be easily shown; for the effect is produced by the channels in which the water flows being formed into syphons. When the hollow of a mountain is so filled by the rills which flow into it as to stand as high as the highest part of the syphon-like channel, the water will flow through it; and it will continue to do so, till it has sunk too low for the syphon to act, when, of course, it will cease.

Mr. E. Thus, my dears, with mamma's kind assistance, I have given you a little lecture on hydrostatics; this, however, suggests a science, on which we must one day converse, called *hydraulics;* and you will sometimes find the two comprehended under the term *hydrodynamics*, from the Greek words for water, and power, or force. You will, however, do well, if you remember all you have now heard.

THE MASONS.

"We have already had several conversations with our children," said Mr. Elwood to his lady, as they were sitting in the arbour one fine afternoon, "on the sagacity of what are called irrational creatures. We have discovered many instances in which they have anticipated the discoveries of modern science, and others in which they labour like artificers; and I have just been reminded, by Cary's translation of 'The Birds of Aristophanes,' that that celebrated Greek dramatist has given an amusing description of them in such circumstances. I will read you a part of it:—

"*Messenger*. Birds, not a soul beside; Egyptian none,
Bricklayer, or stone-mason, or carpenter;
But the birds with their own hands, that 'twas marvellous.
From Lybia came about three myriad cranes,
Who had swallowed stones for the foundation; these
The cornrails* with their beaks did chip and hew.
The storks, another myriad, bare the bricks;
While water to the air from underneath
Was brought by sea-larks and each river-bird.

* Land-rails.

"*Pisthetærus.* And who with mortar served them?

"*Messenger.* Herons with hods.

"*Pisthetærus.* And how did they the mortar throw therein?

"*Messenger.* That too was managed, Sir, most dexterously,
For by their feet the geese with understroke,
As 'twere with trowels, cast it in the hods.

"*Pisthetærus.* O what may not by help of feet be done!

"*Messenger.* Ay, and the drakes, with aprons tuck'd up,
Bare bricks; and after them, like serving lads,
Flew up, with cement in their mouths, the swallows."

Mrs. E. Thank you, my dear; I am not familiar, like you, with ancient lore, and, therefore, this passage has the charm of novelty.—Emma and Frederick, come hither, dears, take your seats on each side of us, and your papa will read you, I am sure, what I have just had the pleasure of hearing.

E. I am much obliged to you, dear papa; but that cannot be all true.

Mr. E. The account is fanciful, my love; but the poet discovers some knowledge of the habits of animals. Many insects and birds are called masons, but the term is, I think, too laxly used. Some persons so denominated work in stone; and to them I can trace little if any resemblance among inferior creatures. But others, particularly in the country, bear the name, who use mortar; and in this they are imitated by many animals, who, like them, not unfrequently employ it as a cement to hold different substances together.

F. Can you think of one, papa?

Mr. E. O yes! Lumps of mortar may often be seen stuck against a garden wall, exposed to the sun; and, if their removal be attempted, no impression can be made upon them by the strongest knife. Now, some careless bricklayer has not done this; it is the house of the mason-bee.* One of these lumps, when separated from the wall, will be found to contain eight or ten cavities, in each of which a larva is placed with its supply of food. The process of building it is remarkable. As soon as the mason-bee has found a proper place for its dwelling, it sets about collecting the necessary material, which is a mortar chiefly composed of sand. The insect seems to be aware that all kinds of sand will not make equally good cement, and that it must neither be too large nor too fine; it selects, therefore, grain by grain, what may suit its purpose, a few such grains only being apparently contained in a heap of sand. One observed by Reaumur felt each grain with its strong teeth; but as it would have been a great loss of time to carry away one by one, it collected together grains enough to form a heap of the size of a small shot, and cemented the mass together with a liquid poured from its mouth. With the gravel and cement it mixed a little earth, which made the whole firmer and stronger; and then it was conveyed to the spot marked out for a nest,

* Megachile.

where the foundation was formed by a circle of these little balls placed in regular succession. On this foundation it raised a very small round tower; and every time a fresh supply of mortar was brought, the insect was seen to twist and twirl it about between its teeth and first pair of legs; it was then laid in its proper place, and moulded into the right shape. As the lower or circular hollow increases in height, the little creature is beheld thrusting its head into the interior of the cell, for the purpose, no doubt, of seeing if the mortar has been properly applied: the inside requiring to be made very smooth, lest it should hurt the young. Each cell is separately formed; the whole, when complete, has a common covering of sand; and the outside is left, as it well may be, in a rough state.

Mrs. E. If, too, the leaf-door and the clay outwork of an earth-worm's hole be cautiously removed, its re-building may often be witnessed. In this case, the worm, finding its barricado gone, will soon set about repairing the damage. To do this, it sucks a few grains of earth into its mouth, moistens it as the swallow does with saliva, and, using its broad tongue for a trowel, plasters it round the mouth of the hole, smoothing it very neatly on the inside, but leaving it rough without, like the swallow's nest. When it has built this clay entrance, it next searches about at a greater distance for a leaf or a stone, and

if it do not find one it is forced to complete the enclosure with clay. The martin,* also, is another mason. It often builds against a perpendicular wall, and, on this occasion, not only clings with its claws, but partly supports itself by strongly inclining its tail against the wall, and, thus fixed, it plasters the materials into the face of the brick or stone. But that this work may not, while soft, incline down by its own weight, the careful builder does not proceed too fast; but by working only in the morning, and giving the rest of the day to food and amusement, sufficient time is allowed for the material to dry and harden. About half an inch seems a sufficient layer for a day. Thus, acting like a prudent and skilful workman, a hemispherical nest is formed in about ten or twelve days, with a small opening towards the top; strong, compact, and warm, and well fitted for all the purposes for which it was intended.

Mr. E. "I remember no bird," says a naturalist, "that seems to suffer so frequently from the peculiar structure of its nest, and by reason of our common observance of its sufferings obtains more of our pity, than the house-martin. The rook will at times have its nest torn from its airy site—have its eggs shaken from it by the gales of spring; but the poor martin, which places its earthly shed beneath the cove of the barn, the roof of the house, or the corner of the

* Hirundo urbica.

window, is more generally injured. July and August are the months in which these birds usually bring out their young; but one rainy day at this period, attended with wind, will often moisten the earth that composes the nest; the cement then fails, and all the unfledged young ones are dashed upon the ground; and there are some places to which these birds are unfortunately partial, though their nests are annually washed down. The projecting thatch of the old farm-house appears to be their safest asylum. The parent-birds at times seem aware of the misfortune that awaits them, as, before the calamity, we observe them hovering with great anxiety about their nests."

E. Poor little things! I wish they knew better; and that their nests were always safe.

Mrs. E. The bird we call the nut-hatch* is named in France "the mason-woodpecker," from her forming a barricade to her nest; probably as a defence from her enemies and a shelter from the weather. The older naturalists say that this bird selects the hole of a tree, and if this be larger than she requires she very dexterously narrows the entrance with earth and mud, neatly kneaded together. Buffon adds, that she strengthens the fabric with small stones, a device which is practised by one of our own mason-bees.†

F. And which of all the mason-birds appears the most skilful?

* Sitta Europæa. † Megachile muraria.

Mr. E. A bird of South America called the baker* is exceeded by few, if any. It builds its nest in an exposed situation on the large leafless branch of a tree, on windows, crucifixes, palisades, or posts, at a considerable height. It is hemispherical, or half-globular, whence its popular name. It is formed of earth, and, though it is of considerable size, it is often completed by two days' labour, the male and female being equally engaged in the task, and each carrying in turns a ball of mortar about the size of a filbert. It is six inches and a half in diameter, and an inch thick. The opening, which is side-ways, is twice as high as it is wide, and the interior is divided into two chambers, by a partition beginning at the entrance and carried circularly backwards, the eggs being placed on a bed of dry grass at the end.

Mrs. E. Beavers,† however, have certainly reached great eminence in this art. The general length of these animals is about three feet. The tail is oval, nearly a foot long, perfectly destitute of hair, except at the base, and marked out into scaly divisions like the skin of a fish. When they wish to construct a dwelling-place, they choose a level spot with a stream running through it, and the first object is to form a dam. To do this, it is necessary that they should stop the stream; and they always do so in the most

* Merops rufus. † Castor Fiber.

favourable spot, and never begin at a wrong part. They drive stakes, five or six feet long, into the ground, in different rows, and interweave them with branches of trees; filling them up with clay, stones, and sand, and ramming them well in, so as to make the whole solid and water-tight. This dam is likewise shaped on the truest principles, so that the most experienced mathematician, or calculator, could not do it better; for the upper side, next the water, slopes, and the side below is perpendicular; the base is ten or twelve feet thick; the top or narrow part two or three, and it is sometimes as long as 100 feet.

F. In what way do they work, papa?

Mr. E. This may be gathered from what M. Du Pratz observed, when he ordered one of his companions to cut a gutter about a foot wide through a dam at the head of one of the rivers of Louisiana, and, having done this as silently as possible, to retire to the hut which had been erected, that the operations of these sagacious animals might be observed at leisure. —As soon as the water, through the gutter thus made began to make a noise, they heard a beaver come from one of the huts and plunge in. He then, with all his force, gave four distinct blows with his tail; when immediately the whole colony threw themselves into the water, and arrived upon the dam. As soon as they were assembled, one of them appeared, by muttering, to issue some kind of orders; for

they all instantly left the place, and went out on the banks in different directions. Some of them formed a substance resembling mortar; others carried this on their tails, which answered the purpose of hods, or barrows. It was observed that they placed themselves two and two, and that each of a couple loaded his fellow. They trailed the mortar, which was pretty stiff, quite to the dam, where others were stationed to take it; these put it into the gutter, and rammed it down with their tails. The noise of the water soon ceased, and the breach was completely repaired. One of the beavers then struck two blows with his tail; and instantly they all took to the water without any noise and disappeared.

E. Why, papa, they are like the constitutionalists you told us of some time ago. They are indeed very obedient and orderly.

Mr. E. Few, if any, creatures are more so; and I should have mentioned them before, had they not displayed so much skill in *masonry.* Beavers generally live in communities, consisting of as many as two or three hundred individuals; and inhabiting extensive dwellings, which they raise to the height of six or eight feet above the surface of the water. They erect their houses on piles, forming them either of a circular or oval shape, with arched tops, giving them the appearance of a dome on the outside; and plastering the inside with surprising neatness. The walls

are about two feet thick; and the floors so much higher than the surface of the water, as always to prevent them from being flooded. Some of their houses have only one floor, others have three; and the number of inmates varies from two to thirty. These sleep on the floor, which is strewed with leaves and moss; and each one is said to have its own place. It costs a whole season to build the houses of a new settlement, and lay in their winter provisions; which consist principally of bark and the tender branches of trees, cut into certain lengths, and piled in heaps under water. Now, my dears, you may resume your gambols. The proofs have been increased this afternoon,

"That things improbable may still be true."

HYDRAULICS.

"Now, my dears," said Mr. Elwood to his children, "we will turn from the fields where the wheat-crops shine, as the poet says, 'like golden shields cast down from the sun;' and walk by the side of the river. The verdure of the brooks, you may observe, is still rich, their plants having, notwithstanding the heat, a constant supply of moisture; reeds, bulrushes, and water-flags have attained their maturity; the lilies, one of which Cowper's dog, you may remember, laid at his feet, still show their white and yellow flowers; and all around tells us of 'sober autumn fading into age.' Ah!—look at that rat! See, he has cropped off a leaf, and is now bearing it away to his snug retreat! He is unjustly treated as a thief, for he is one of those who almost entirely live upon herbage. But 'no tree,' says Evelyn, 'affords so cool a shade as the willow;' let us then take a seat under this for a few minutes, and see if we cannot find something that is instructive."

F. Papa, I just saw a fish rise to the top, and there

is another—and another—are not their motions very singular?

Mr. E. They are, my dear. Let us, however, mark one thing first. The fins help to balance the fish, and also to give it motion. The pectoral fins, or those nearest the head, and more particularly the ventral fins, or those about the belly, serve to raise or depress the fish. When it desires to go back, its wish is accomplished by a stroke forward with the pectoral fin, if it desires to turn on one side, a shake of the tail, the opposite way, sends it round at once: if the tail strike both ways, the fish advances with great velocity. If, however, the tail be cut off the fish loses all motion. The fin at the end of the body acts as the keel of a vessel, the ventral fins as outriggers, and the pectoral, like oars. But I remember I promised you some information as to *hydraulics,* which has for its object the investigation of the motions of fluids, the means by which these motions are produced, the laws by which they are regulated, and the force they exert against themselves or against solid bodies which may oppose them. Of this the rat and the fish afford some illustration, since each of them has to overcome the *resistance* of water, which has called forth many experiments by those engaged in this science, — to prove how canals should be formed with most advantage, and how vessels should be shaped to meet with least obstruction in their course.

The structure of fishes would doubtless aid them in this particular. Unlike birds, they have very nearly the same specific gravity as the element in which they move; and, therefore, as they have little or no weight to bear up, all that is wanted is an impulse sufficient to carry the body through a resisting fluid—to maintain their posture—or to support or restore the balance of the body, which is always the most unsteady where there is no weight to sink it; and these purposes the fins answer. Now we will walk gently, and converse as we go. But, do you see that beautiful little creature on the bank? How its wings sparkle in the sun! —Stop! I'll try to catch it!—softly—now, don't stir, Emma,—Frederick, go back—I have it!

E. What is it, papa? O, I see! a beautiful insect. What splendid colours! Scarlet—green—blue—yellow! And then what brilliant eyes! and its wings —how wide they spread, and how delicate they are!—how *very* delicate! What do you call it, papa?

Mr. E. The dragon-fly,* my dear; now you have both seen it, we'll let it go. Some particulars of its history when in the larva state will delight you, especially as it is provided with a hydraulic apparatus. Though the larva or grub has six feet, it does not use them so much for walking as for seizing its prey; and its motion is most extraordinary. Some years ago, it was proposed to shoot a stream of water by a steam-engine out of the

* Libellula.

stern of a boat, so that the impulse of the stream on the water in the river might push the boat itself forward; and this is the very method the larva adopts.

F. And so, papa, the insect did this hundreds of years before the mechanic!

Mr. E. Thousands, my dear, thousands of years before. But listen to the process! If you take one, and put it into a large saucer of water, with some of the dead leaves or sticks it had for a covering, these will soon float towards the tail, and afterwards be driven back by a little stream it throws out; and to do which it is provided with a wonderful apparatus. If it be held head downwards, and some drops of water be let fall on its tail, it instantly sucks them in, when its body becomes larger; but its size is lessened when the water is expelled. If a coloured fluid be let down just over the tail of the insect, it will throw out a stream of it several inches. Now this stream causes its motion, because it is resisted by the still water behind, and a contrary current being thus produced by this singular pumping. Nor is this all; it seems to breathe partly by this means, and to have small water-insects brought within its reach.

F. Most curious indeed, papa!

Mr. E. It has also a most singular under lip, which conceals the mouth and face when it is at rest. But when the grub would make use of it, it unfolds it like an arm, catches the prey, and then partly refolds it

so as to hold the prey to the mouth in the most convenient manner. In some cases it is exactly like a mask, but it does not trust to this alone for surprising its prey, for it steals upon it as a cat does on a bird, and then, by suddenly unmasking, seizes it by surprise.

E. O the cunning little thing! I never heard of such a sly-boots. I shall not soon forget his pump, and his mask! Papa, is there any thing else strange about him?

Mr. E. Yes, his leaving the chrysalis. When about to do this, the chrysalis, or pupa, becomes more transparent, and the eyes far more brilliant. It removes out of the water to a grassy bank or the stems of water-plants, to which it fastens itself by its sharp claws. The upper part of the body swells; the covering bursts asunder on the back of the head and shoulders, and through the opening, first the head, and then the legs of the perfect fly issue. After this, it hangs down its head and rests a space. It next raises itself, and, laying hold of the upper part of what still clings to the feet, it draws the covered parts of the body gradually out, and then rests again. The wings now begin to expand, the body to become larger, and the limbs to have their just size; and, while the wings are stretching and drying, the insect bends itself into the form of a crescent, that they may not touch the body and thus receive injury.

E. Why, papa, it is altogether wonderful.

Mr. E. It is so indeed. I have already told you of the pressure of fluids, but I have yet to state, that as the pressure of a column of water of about thirty-three or thirty-four feet is equal to about fifteen pounds on a square inch, so at the depth of as many fathoms, the pressure will be six-fold, and so on for greater depths. To prove this, Mr. Campbell tried, in his voyage from the Cape of Good Hope, the following experiment:—He drove, very tight, into an empty bottle, a cork, which was so large that half of it remained above the neck. A cord was then tied round the cork, and fastened to the neck of the bottle, and a coating of pitch was put over the whole. When it was let down to the depth of about fifty fathoms, it appeared, from the additional weight, that it was instantly filled, and, upon drawing it up, it was found that the cork was forced in, and, of course, the bottle filled with water. The experiment was repeated; the bottle was corked as before, with the additional precaution of making a sail-needle pass through it, so as to rest on each side on the neck, the whole being pitched over as before. The bottle was again let down to the same depth, and on raising it up it was found to be filled with water, although the cork still remained in its first position, and no part of the pitch seemed to have been disturbed.

F. How, then, papa, could the water get in?

Mr. E. It is supposed, my dear, *through the pores of*

the glass. Now we have before us another hydraulic machine. There stands a large mill for grinding corn. Some are worked by steam, others by wind, but this is put in action by water. Look, and you will observe the water-wheel, as it is called, with long planks placed all round the rim, called float-boards; now the water is so directed as to fall on these, one after the other; thus the wheel is made to go rapidly round, and this gives motion to the mill-stones, which grind the corn.

F. Are such mills much used, papa?

Mr. E. Not so much as they used to be, my dear; but I observed a very remarkable instance of the power of water when last in Scotland. I was at the town of Greenock, in Renfrewshire, and remember well the delightful walk I had, with the beautiful scenery of the Clyde almost always in view, to trace what is called the Shaws Water-works from their source to their termination. There, a small stream of water is made to travel along the faces of mountains, and across several ravines, in a very curious manner, for the space of six miles and a half from a grand reservoir, till it reaches the brow of a hill, a mile above the town, at the height of 512 feet above the level of the sea. Here it is so skilfully and carefully employed as to produce, by a splendid fall, a power equal to that of 2000 horses—greater, it is said, than that of all the steam-engines in Glasgow, the great emporium of the west of Scotland.

F. That is very clever, papa; but don't they use a great many pumps? I looked at ours the other day, when the man was mending it, but I could not make it out at all.

Mr. E. That, too, is a hydraulic machine, and one of great use and value. The larva of the dragon-fly seems to have one in its inside, as another little creature I mentioned to you appears to have an air-pump in its body; but I will explain the structure of the one to which you refer. A pump is a cylindrical vessel, in the pipe or body of which what is called a piston works; this fits the inside exactly, and goes up and down, as the handle moves, which is connected with a rod passing through the middle. Now in the centre of the piston there is a valve, or little door, which, opening upwards, allows the water to rise through it, but it immediately falls, and thus prevents its going back; and there is a similar valve in the body of the pump. When the pump is not set in motion, the two valves are shut by their own weight; but when, by drawing down the handle of the pump, the piston ascends, it produces a vacuum between the piston and the lower valve; the air beneath this, which is just over the surface of the water, consequently expands, and forces its way through it; and then the water, being relieved from the pressure of the air, rises in the pump. If, however, when you return home, you will look in the Encyclopædia for a description and

engraving of the common pump, this will aid you in understanding and remembering what you have heard. The mother of Sir W. Jones was accustomed to reply to some of his questions, "Read, and you will know;" and so I may say, my dears, to *you*. I have, however, in reserve what is more wonderful than any thing I have told you this morning.

E. O, dear papa! what can that be?

Mr. E. The human heart, my love, which is provided with many pumps and pipes for the circulation of the blood. One set of vessels is required to take the blood to the heart, and another to take it back. The human body, therefore, contains two systems of blood-vessels, arteries and veins, the arteries having, as is necessary, much tougher and stronger coats than the veins; and, as a wound in them would be more dangerous than one in the veins, they are defended from injury in a most wonderful manner. The heart has an amazing power of expanding and contracting: when it contracts, a portion of blood is forced by a little pump into the arteries; and when it expands, an equal quantity is received from the veins. This, moreover, has *valves*, which, like flood-gates, open a way to the stream in one direction, and shut up the passage against it in another. At each pulse the mass of blood which the heart contains, and which in a man or woman is about two table-spoonsful, undergoes a change.

F. How much blood passes through the heart in an hour?

Mr. E. Four thousand ounces; and as the whole mass of blood is said to be about twenty-five pounds, a quantity of blood equal to the whole mass passes through the heart fourteen times in one hour, which is about once every four minutes. The amazement we feel at this is increased as we examine the heart more particularly. I have told you but a small part of its wonders. How many are the vessels through which the blood circulates! The point of a pin will draw it from any part of the body; and blood-vessels run along the surface of membranes, pervade the substance of muscles, and even penetrate the bones. Every tooth has an artery to feed the bone, and a vein to bring back the spare blood; both which, in addition to an accompanying nerve, form a thread only a little thicker than a horse-hair.

E. And then, papa, how often it beats!

Mr. E. Yes, this wonderful machine goes sometimes, night and day, for eighty years, at the rate of a hundred thousand strokes every twenty-four hours, having, at every stroke, a great resistance to overcome; and yet so long and even longer does this action continue, without disorder, weariness, or pain. Well has it been said, "The wisdom of the Creator is in nothing seen more gloriously than the heart."

THE DOMESTIC ECONOMISTS.

"I WOULD not have been Alexander Selkirk, who lived on an uninhabited island, for the world," said Emma.

"And why not?" enquired her father.

"Because, papa," she replied, "I love home better than any place. How delightful are the parlour, the drawing-room, and the library, when you, and mamma, and Frederick are there! And then what a charming garden we have, so full of flowers and fruit. I love the orchard, too, and the meadows, and the woods, and the river-side;—no one's house and grounds seem half so pretty as ours; and I'm sure—yes, I'm quite sure, that I am not so happy any where else. I should not think any one would like to live alone."

"Few of our species prefer it, my dear," said Mr. Elwood, "but some creatures may be considered solitary beings. There is a singular creature, for instance, called the hermit-crab; * and if you will go and ask mamma to come, and call Frederick, I will relate a curious fact."

* Cancer Bernhardus.

Away bounded Emma, with great hilarity; and in a few moments, she returned with the objects of her search. The circumstance Mr. Elwood promised to mention was the following:—

Having no shell to any part but its nippers, one of which is as thick as a man's thumb, and sufficiently strong to inflict a very severe wound, it supplies by art what is denied by nature; for, taking possession of the deserted shell of some other animal, it occupies that, till, by becoming too large for its habitation, it is under the necessity of changing it.

This animal may be observed in some countries busily parading the sea-shore, along the line of pebbles and shells formed by the furthest wave; still, however, dragging its old inconvenient habitation at its tail, till it can meet with one more commodious. It stops first at one shell, turns it, passes by, then goes to another, considers that for a while, and, slipping its tail from the old dwelling, tries on the new. This also is found inconvenient, and it quickly resumes the old one. In this manner, it frequently changes, till at length it finds one light, roomy, and commodious. To this it adheres, though the shell be sometimes so arge as to hide both the body and claws of the animal.

But many trials and combats are sometimes sustained by the hermit-crab, before he is thus completely equipped; for there is often a contest between two of them for some favourite shell. They both endeavour

to take possession. They strike with their claws, and bite each other, till the weakest is compelled to yield. The victor then takes possession, and, in his new acquisition, parades backwards and forwards on the strand, before his envious antagonist.

Many caterpillars are called solitary, (Mr. Elwood added,) from their being little hermits, or living alone.

E. And that, papa, is just what I should not like. I always think it's very dull for Miss Rebecca Collison to be so much by herself; and I am sure I should not think her parrot, cats, and lap-dogs any company.

Mr. E. A great many persons feel as you do, Emma, and inferior creatures resemble them; hence they "pair," as it is called, and become domestic economists.

E. I should like to know very much indeed how they manage their affairs at home; and whether they do many things like us.

Mr. E. A great many, my dear; and mamma and I will endeavour to recollect some. Social feelings and habits are often apparent; thus a cow or a sheep is happier and thrives better when amongst its fellows, than when kept in a cottage-paddock alone. Even two or three are not content by themselves; and every effort is often made to leap hedges, and cross ditches and canals, by small groups of cows, desirous of associating with their kindred—the parties on the

other side seeming equally solicitous to surmount the obstacle. "Such endeavours," says Mr. Rennie, "have always reminded us of the Frenchman in the back settlements of Louisiana, who, if we may credit the Abbé du Pratz, annually travelled to New Orleans, a distance of three hundred miles, for no other purpose than to find people to talk with." A remarkable proof of the influence of social feelings was given by a sparrow, of which I have read. It belonged to a lady who lived at Fulham; and when she went for the winter to her house in London, she conveyed the sparrow, having covered his cage, in the carriage. The window of the drawing-room in which the bird was one day suffered to fly about, was left open some months after, when it took its flight, and was lost, without hope of recovery. About ten days after, the lady sent a servant to Fulham, who told the maid left there of losing the sparrow, and of his mistress's concern; on which she observed, that, for a day or two, a sparrow had come constantly into the kitchen, and, with unusual familiarity, had placed itself upon the chairs and dressers. It proved to be the very sparrow that had escaped from London, and had been a week reaching Fulham. The following spring the same bird formed an attachment to a female of his own kind, and made a nest; and, in order to gather materials for it, he frequently visited the house for bits of rag, or thread, which he carried away in his

beak. Sometimes he brought his wife into the parlour, and once was accompanied by all his little ones; but they were soon alarmed, and flew away. When they were able to take care of themselves, he returned to his kind protectress, and lived in the room as before.

E. Now, papa, I'm just like *that* sparrow: I like to be at home; and I like those I love to be with me.

Mrs. E. Insects do not seem to pair, as linnets, sparrows, and other birds, to afford mutual assistance in rearing their young. Where laborious operations have to be performed, we might have expected that the male would give his aid; but even in the structures of the mason-bee, or the carpenter-wasp, the female seems to perform the whole labour. We have already conversed respecting the buildings of various animals, but *the cleanliness* of some of their abodes has not hitherto been noticed; and yet, what a difference is there between dwellings in which it is regarded, and others where it is neglected! Many families might take pattern by bees; they will not suffer the least filth in their abode. It sometimes happens that an ill-advised slug, or ignorant snail, chooses to enter the hive, and has even the audacity to walk over the comb: but the presumptuous and foul intruder is quickly killed. Unable, however, to remove the corpse from their dwelling, and fearing the effects of what is corrupt, they adopt an efficacious mode of

protecting themselves: they actually embalm their offensive enemy, by covering him over with propolis. Reaumur observed that a snail entered a hive, and fixed itself to the glass side, just as it does against walls, until the rain shall invite it to thrust out its head beyond its shell. The bees, it seemed, did not like the intruder, and not being able to pierce the shell with the sting, what could they do?—They took a hint from the snail itself, and fixed it immoveably, by cementing the edge of the shell to the glass with their resin, and thus it became a prisoner for life. What shall papa tell you next that resembles what occurs at home?

E. I never think of home, mamma, without remembering *how kindly you and papa treat us*—can he mention, I wonder, any thing like this?

Mr. E. A wonderful provision is made for the young of all animals. However savage the natural disposition of the parents may be, they are almost always affectionate to their offspring, and provide, with the utmost tenderness, all that is necessary for them. Even bears are very attentive to their young; and the habits of female monkeys in nursing their cubs are very amusing. The dams keep their little ones generally within reach of their hand, and always of their eye. While swinging about on the boughs of the trees, or scampering along the walls, if a giddy thing attempts to get too far from her, the dam darts

forth her paw, catches it by the tail, or, should the tail slip through her fingers, lays hold of a leg, and gently pulls the truant back. On any alarm or disturbance, she huddles it instantaneously to her breast; the little one clasps its arms and legs round her body, and remains closely attached, while she runs up the trunk of a tree, or seeks security on the extremity of a branch. Frequently the cubs mount on their mother's shoulders, vault back again, frisk or lay down, at a growl, a beck, or a grin—for she seems to rule by a set of nursery-signals well understood. Enemies are sometimes powerful, but the dams will stand forward in defence of their young, and die rather than yield them up. The sheep discovers true maternal care, and the sky-lark is an admirable mother. From her, Goldsmith borrowed an idea to show the affection of the pious pastor:—

> And as the bird each fond endearment tries,
> To tempt its new-fledged offspring to the skies,
> He tried each art, reproved each dull delay,
> Allured to brighter worlds, and led the way.

But the instances of kindness on the part of parents are very numerous.

F. Now, mamma, we should like a story of the same kind from you.

Mrs. E. The eider-duck has frequently been praised for her maternal care in stripping the down from *her*

own breast to form her nest, an act which is also performed by the common rabbit; but these are surpassed by more than one moth; for they, not satisfied with a nest made of their own down, eover with it *every egg*. The female of the gypsey-moth,* for example, has the hinder parts of her body thickly clothed with a soft down of a hair-brown colour, which is wanting in the male, evidently because to him it would be of no use. As a covering for her own body, it can be but of small service; and hence, when about to lay, she places herself on the trunk of an oak, or an elm, and always with her head downwards. Without the aid of her legs, she tries to place her eggs in the form of an inverted cone, or sugar-loaf turned upside down. She first makes a little bed of this down, into which she thrusts the egg intended for the point of her cone, and this egg, being covered with gluten, fastens around it all the hairs of the down it touches, and also sticks to the bark of the tree. Proceeding in the same manner, she continues for several hours adding to the mass; but, in general, she does not finish her work in less than two days, as she rests occasionally when tired with labour. At intervals, also, she takes care to protect the eggs placed in the cone with an outward covering of the same down. Another part of her movements is not a little remarkable. In

* Hypogymna dispar.

the bed which she first makes for the eggs, the hairs of the down either point at right angles to the bark of the tree, or, at least, are tossed down with little regularity; but, in the outer part, which is designed to keep out the winter rains, the hairs are carefully placed *in a sloping direction,* like the tiles of a house, pointing downwards towards the base of the cone. The eggs, thus cared for, abide all the pitiless pelting of the storms of winter; for, although they are laid in August, they are not hatched till the elm comes into leaf in the following spring. Accordingly, this covering protects them, not only from wet, but from severe cold. Now, Frederick, what else shall we relate?

F. I was thinking I should like to hear something about *clothes;* you know, mamma, we have many.

Mr. E. The covering of animals is as much to be admired as any part of their structure. There are bristles, hair, wool, furs, feathers, quills, prickles, scales; yet we cannot change the coat of one animal for another, except for the worse; nor should we forget that these coverings are often armour as well as clothing—protection as well as warmth. The clothing of animals changes, of its own accord, with their necessities. This is particularly the case with quadrupeds which are covered with furs. These thicken at the approach of winter. Wool, in hot countries, passes into hair; whilst hair, on the dogs

of the polar regions, is turned into wool, or something very like it. The covering of birds is remarkable for its lightness, smoothness, and warmth; but it would imbibe the moisture of the atmosphere, and, during rain, absorb so much wet, as would almost, if not wholly, impede their flight, had not this been effectually prevented by singular means.—They have two glands, in which a quantity of matter is constantly secreting, to be occasionally pressed out by the bill, and used to lubricate or moisten the feathers. The birds that share, as it were, the habitations of man, and live principally under cover, do not require so great a stock of this fluid as those that exist in the open air; and it is on this account that poultry, when wet, look so ruffled and uncomfortable as they do. Paley says, "the human animal is the only one which can clothe itself;" but, though this accords with what is known of quadrupeds, birds, and fishes, it by no means holds good in the insect world. Many proofs I hope yet to give you in future conversations. We shall observe the cutting out and fitting of various garments and mantles, which no tailor on earth could equal. One case, however, occurs, which I will mention now, for, as man has pressed into his service not only the wool, the hair, but even the skins of animals, he is rivalled by tiny creatures which select a material for their covering peculiarly warm. As the seed catkins of the willow ripen, they are covered

with a species of down or cotton, which, though too short in the fibre to be used in our manufacture, caterpillars use for a muff-looking tent. Contented with the state in which it finds it on the seed, the insect burrows in this, lines the inside with silk tapestry, then separates the whole from the branch where it was growing, and carries it about as a protection while it is feeding. It is even possible that the tent may be designed to act as a life-boat, so that, when the little inhabitant is blown into the water, it may reach the shore in safety, and regain its native tree. But can you guess how a covering is provided for the lobster? Shells, like those of oysters, grow larger from an accession of substance at their edge; it is the same with spiral shells at their mouth. But the lobster's shell, being applied to the limbs of the body as well as to the body itself, allows not of either of these modes of growth; how then was it, hard and complex as it is, to be provided for? Was room to be made for it in the old shell, or was it to be fitted with new ones? If a change of shell became necessary, how was the lobster to uncase his buckler, or draw his legs out of his boots?

F. Oh, papa, I am sure I could never tell!

E. Nor I, indeed, papa.

Mr. E. Then listen to what fishermen have observed to take place. At certain seasons, the shell of the lobster becomes soft; the body of the animal

swells; the seams open; and the claws burst at the joints. When the shell has thus become loose upon the body, the animal makes a second effort, and, by a tremulous motion, casts it off. In this state, the liberated but defenceless creature retires to a hole in the rock. The released body now suddenly increases in size. In about eight-and-forty hours a new shell is formed, adapted in every part to the increased size of the animal. This wonderful change is repeated every year.

F. That's very surprising! But we have *food* as well as clothes.

Mr. E. The preparation of this for plants as well as animals marks out the beneficence of God. The fly-trap,* or fly-catcher, has small prickles in the inside of two leaves, or half leaves, joined by a hinge; and a juice, or syrup, is found on their inner surface, which acts as a bait to flies. There are several small spines or prickles standing upright in this syrup, and upon the only part of each leaf that is sensitive to the touch. When the fly, therefore, settles on this part, its touching, as it were, the spring of the trap causes the leaves to shut, and kill and squeeze the insect, so that its juices, and the air arising from their rotting, serve as food to the plant. Here, then, is some resemblance to the skill with which animals provide for themselves and their offspring. Cattle, indeed, have an acuteness and nicety of taste.

* Dionæa muscipula.

Nothing will ordinarily induce them to take what is not their natural food. Grass is commonly eaten by them all, but they make their favourite selections of other plants—the goat, for instance, feeding greedily on hemlock, which, to others, is a deadly poison. Insects seem still more particular. The caterpillar of the antler-moth, though it feeds on a variety of grasses, does not touch the fox-tail grass, which can scarcely, if at all, be distinguished from what it eagerly devours. Some insects leave one person out of many unbitten, and one mite chiefly attacks women and children. One little creature, however, must not be forgotten, for a most laborious task is performed by an insect by no means uncommon in Britain, called the burying-beetle.* A foreign naturalist, M. Gleditsch, had often remarked that dead moles, when laid upon the ground, especially if upon loose earth, were almost sure to disappear in the course of two or three days, and often of twelve hours. To ascertain the cause, he placed a mole on one of the beds of his garden. It had vanished by the third morning; and, on digging where it had been laid, he found it buried to the depth of three inches; and, under it, four beetles, which seemed to have been the agents in this singular interment. Not perceiving any thing particular in the mole, he buried it again; and, on examining it at the end of six days, he found it swarming

* Necrophorus vespillo.

with maggots, apparently the offspring of the beetles, which M. Gleditsch now naturally concluded had *buried the carcase for food for their future young.* To place this beyond doubt, he continued his experiment; and, in fifty days, four beetles had buried, in a very small space of earth, four frogs, three small birds, two fishes, one mole, and two grasshoppers; besides the entrails of a fish, and two morsels of the lungs of an ox, all evidently intended for the same purpose.

Mrs. E. It is, too, a well-attested fact, that ants keep and feed other insects, such as plant-lice and gall-insects; from which they extract a sweet and nutritious liquid, in the same manner as we obtain milk from cows. "The milch-cattle of the ants," as Linnæus calls them, absorb the sap of trees, which, having passed through the digestive system, is thrown to a distance if no ants are near; but if they are, they carefully watch for it, and immediately suck it down. What is more surprising, they know how to milk these creatures, and their antennæ or horns act like the fingers of a milk-maid. When one aphis is milked, the ant goes to another; and so on until it is satiated, when it returns to its nest. It appears, also, that these *cows* are not always considered the common property of a whole tribe, but some belong to a particular hill or nest, and the inhabitants use all their skill and industry to keep them to themselves.

E. I shall not easily forget the dairy of the ants; but I was thinking, mamma, that *we* could not go on as we do without speaking; and you know such creatures cannot talk.

Mrs. E. No, yet still they can communicate with one another. A kind of interchange of feeling is often observable. When several horses travel in a line, the first always points his ears forward, and the last directs his backward; whilst those in the middle seem quite careless in this respect, as if they trusted to their companions to listen to any sound of danger. It would be difficult to say that this was not preconcerted; and equally so to refer many other things to mere instinct. Bees have certainly a medium of communication. The effects produced by the loss of their queen will furnish proof of the fact. In a well-peopled and thriving hive, each bee attends to his appropriate business; some in making cells, and others in minding the young. At first, when the queen has been taken away, all goes on well for about an hour: afterwards some few of the workers appear much agitated; they forsake the young, relinquish their labour, and begin to pace the hive in a furious manner. Whenever they meet a companion, they cross their antennæ, or horns; and the one which seems first to have discovered the national loss, communicates the sad news to his neighbour, by giving it a gentle tap with these organs. This one becomes

agitated in its turn, and runs over the cells crossing and striking others. Thus, in a short time, the whole hive is thrown into confusion, every thing is neglected, and the humming may be heard at a distance. This agitation lasts from four to five hours, after which the bees are calmed, and begin to adopt the necessary measures to repair their loss.

F. Can you think of any more instances, papa?

Mr. E. Dr. Franklin was of opinion that ants could communicate their ideas to each other; in proof of which he related the following circumstance:—Having placed a pot containing treacle in a closet infested with ants, these insects entered it, and were feasting very heartily when he discovered them. He then shook them out, and suspended the pot by a string from the ceiling. By chance one ant remained, which, after eating its fill, found its way up the string with some difficulty, and thence, reaching the ceiling, escaped by the wall to its nest. In less than half an hour a great company of ants sallied out of their hole, climbed the ceiling, crept along the string into the pot, and began to eat again. This they continued until the treacle was all consumed, one swarm running up the string while another passed down. It seems indisputable that the one ant had, in this instance, conveyed news of the booty to his comrades, who would not otherwise have directed their steps in a body to the only accessible route.

Mrs. E. I can add to what you have heard another anecdote or two illustrative of the faculty by which animals can communicate their ideas to each other. At Horton, in Buckinghamshire, a village where our great poet Milton passed some of his early days, a gentleman from London took possession, about the year 1818, of a house, the former tenant of which had moved to a farm about a mile off. The new inmate brought with him a large French poodle, to watch, in the place of a fine Newfoundland dog, which went away with his master; but a puppy of the same breed was left behind, and he was constantly persecuted by the poodle. At length the puppy was one day missing for some hours; but when he returned it was with his old friend, the large house-dog, *whom he must have told of the fact;* for in an instant the two fell on the unhappy poodle, and killed him before he could be rescued from their fury. Other instances are even more singular than this. A surgeon of Leeds, walking in the suburbs of that town, found a little spaniel who had been lamed. He carried the poor animal home, bandaged up his leg, and, after two or three days, set him at liberty; but he returned to the surgeon's house every morning, till his leg was perfectly well. At the end of several months the spaniel again appeared, in company with another dog, who had also been lamed, and he told—as well as his intelligent and piteous looks could tell

that he desired the same kind assistance to be given to his friend as had been bestowed on himself.

E. O, mamma! how I should have liked that little spaniel! How sagacious he was!—and then how kind, too! I hope you won't stop yet—these stories are quite delightful.

Mrs. E. I love to gratify you, my dears; but papa, I see, is taking out his watch, and I have an engagement to which I must attend. Some other time we shall be happy to tell you more.

THE ILLUMINATORS.

Mr. Elwood had just returned from town, when, after telling his lady and children what he had witnessed, and describing the royal procession to the Abbey, when our beloved king and queen were crowned, Emma begged to know if he had seen the illuminations. His reply was, that he had often had such a sight, and, therefore, felt little desire for its repetition; but that he had taken two of his nieces to look at those formed with *gas*, which were very splendid. This led to the following conversation.

F. How is gas made, papa?

Mr. E. It is obtained from coal. All flame is gas set on fire. But gas is procured from various substances. To make that I now speak of, a quantity of coal is strongly heated in large iron vessels, called retorts, which have but one opening, out of which the gas goes into what is called a reservoir; just as the water in the kitchen runs from a pipe into the cistern. When I was a boy, like Frederick, I often put some small coal into a tobacco-pipe, and when I had covered

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the bowl with clay, to prevent the gas escaping at the top, I placed it between two bars of the grate, and the coal becoming hot, gas was made, came out of the tube of the pipe, and, being lighted, burned till all the coal contained was consumed. This, then, was a gas-light on a small scale.

F. When, papa, was it first thought of?

Mr. E. A patent was taken out by Lord Dundonald, between forty and fifty years ago, for making what is called *coke.* Coke is coal half-burned, and, when this is done, the tar and gas which were in the coal are taken away; and, as his lordship wanted only the coke, the gas was conducted under water many hundred yards, in order to condense the tar, that is to make the gas leave the tar behind; it then went up a high chimney, and by some means taking light, continued to burn, and illuminated the country for twenty miles round.

E. How beautiful and grand it must have looked! I wish I had seen it! But, papa, was this the *first* gas-light—I mean the *very first?*

Mr. E. I was going to tell you, my love, that there was a chemist, long before, who made gas from coal, filled bladders with it, and amused his friends by pricking a hole in one of them, and applying a light to it. Many—many years elapsed before gas was used for any valuable purpose, but latterly, it has made many shops very brilliant—scattered the darkness of

our streets—and for an illumination, it certainly surpasses every thing else.

Mrs. E. By the way, what a contrast there is, between our days and those of King Alfred, in this respect! Clocks were then unknown, and so he measured the time by candle-light.

E. Oh, mamma!—mamma! Surely you are joking! And yet you don't look as if you were either. Do pray tell us how he did this?

Mrs. E. Having made his chaplains obtain the necessary quantity of wax, he ordered six candles to be prepared, each twelve inches long, and these he found would together burn for twenty-four hours. Having marked the inches on them, he ordered that they should be lighted in succession, and for every three inches consumed, he reckoned that an hour was gone.

F. But, mamma, would the candles always burn alike? The doors and windows were not so good as ours, and suppose a strong wind was to blow through the wall, or the tent, would not the candles flare and burn down *sooner?*

E. I thought of that too, mamma; and then you know Alfred might make a mistake, and say, as Frederick and I do sometimes, when you tell us these pretty things: "Dear, it's nine o'clock! We've been talking an hour, and I'm sure I thought it was only a few minutes!"

Mrs. E. Alfred found this out, my dears, and so he ordered a lanthorn to be made of wood and horn,—for white horn, when scraped thin, allows the light to pass through just like glass — and the candle being placed in the lanthorn, it was defended from the wind, and shone during the night as brightly without as within. But it has just struck me that papa might tell you of a great many more illuminations besides those of gas.

Mr. E. Thank you, my love,—that is a good and a kind thought. I will mention what I remember, and, by your aid, we may have much that is pleasing.— How delightful it is to go forth on a fine morning, when the air is so fresh and balmy, and the sun shines, and to observe—

> " ——— Herb, tree, fruit, and flower,
> *Glistening* with dew."

Plants may, however, be radiant from other causes. A gentleman mentions that he observed, in the shady recesses of some of the rocks of Derbyshire, a singularly brilliant, golden-green light, rivalling the gorgeous tints of the humming-bird, which appears to have been given out by a very delicate *vegetable* net-work. But who that enjoys the country does not know that, on summer evenings, in meadows, lanes, and hedges, the glow-worm lights his gem; and—

——— through the dark
A moving radiance twinkles?

Well have these little creatures, which somewhat resemble a caterpillar in shape, been called "stars of the earth, and diamonds of the night."

Mrs. E. Doctor Smith tells us that gentlemen of Italy often adorn the heads of the ladies with a species of beetle which emits a brilliant light,* these they place in their hair; and a similar custom is said to prevail among the ladies of India.

Mr. E. Another insect of the beetle-tribe has the same, and indeed much greater power. So great is its light, that the smallest print may be read by moving one of these insects along the lines; and, in the West Indies, particularly in St. Domingo, the natives often used them of an evening instead of candles. When they travelled at night, they tied one to each great toe; and in fishing and hunting required no other torch. Do you recollect any other instances, my dear?

Mrs. E. Yes; the poet Southey makes this insect a lamp, by which Coatel rescues the British hero from the Mexican priests:—

> "She beckoned and descended, and drew out,
> From underneath her vest, a cage, or net
> It rather might be called, so fine the twigs
> Which knit it, where, confined, two *fire-flies* gave
> Their lustre. By that light did Madoc first
> Behold the features of his lovely guide."

Elater noctilucus.

In the Spanish West India Islands, they destroy the gnats, which are there a dreadful pest; and, on certain festival-days, in the month of June, they are collected in great numbers, and tied all over the garments of the young people, who gallop through the streets on horses similarly adorned,—thus appearing like a large moving body of light.

E. Now I see papa has thought of something. He looks just as if he had.

Mr. E. You are right, my dear; I have just recollected that Mouffet tells us that when Sir Thomas Cavendish, and Sir Robert Dudley, first landed in the West Indies, and saw in the evening a great number of moving lights in the woods, which were merely these insects, they supposed that the Spaniards were advancing upon them by torch-light, and immediately fled to their ships. One story, however, calls up another. I remember hearing of a gentleman, who was riding by night in that country, when he found his horse stopped, but by what means he could not tell. At that moment, some fire-flies passed, when he saw it had been done by a slave on each side of his horse. Satisfied that they intended to rob or murder him, he drew out his pistols, and shot them dead. Perhaps mamma can tell us what Southey has said of these radiant creatures!

Mrs. E. "——— One while they streamed
A bright blue radiance upon flowers that closed

Their gorgeous colours from the eye of day;
Now motionless and dark, eluded search,
Self-shrouded; and anon, starring the sky,
Rose like a shower of fire."

E. Oh, mamma, mamma, how grand that must be! What a splendid illumination! And then how prettily it is described! But when shall I know as many things as you?—Have we any such creatures here besides the glow-worm?

Mr. E. I am not aware that any other native insect is luminous except the electric centipede,* which is by no means uncommon, though its light is rarely seen, in consequence of its living in holes or under ground, from which it is seldom roused during the night.

F. How is this light produced, papa?

Mr. E. That I will tell you when we talk, as I intend we should some day, about the science of chemistry. Meanwhile, I may mention that there is a bird celebrated in India for lighting up her nest during the night with glow-worms, or fire-flies, which are thus, as Mr. Wakefield says, "an emblem of beauty, that so often misleads its possessor into error and folly." Sir William Jones has described the nest of the Indian sparrow:†—I will reach down the volume, and Frederick shall read what he says.

* Scolopendra electrica. † Loxia Bengalensis.

F. (*Reads.*) This bird is exceedingly common in Hindoostan; he is astonishingly sensible, faithful, and docile, never voluntarily deserting the place where his young are hatched, but not averse, like most other birds, from the society of mankind, and easily taught to perch on the hand of his master. In a state of nature, he generally builds his nest on the highest tree he can find, especially on the palmyra, or on the Indian fig-tree, and he prefers that which happens to overhang a well or a rivulet: he makes it of grass, which he weaves like cloth, and shapes like a bottle, suspending it firmly on the branches, so as to be rocked by the wind, and placing it with its entrance downwards to secure it from the birds of prey. His nest usually consists of two or three chambers, and it is popularly believed that he lights them with fire-flies, which he is said to catch alive at night, and confine with moist clay. That such flies are often found in his nest is indubitable; but as their light could be of little use to him, it seems probable that he only feeds upon them. He may be taught with ease to fetch a piece of paper, or any small matter that his master points out to him.

Mrs. E. The young Hindoo women of Benares and other places, wear very thin plates of gold, called *ticas,* slightly fixed by way of ornament between their eye-brows, and when they pass through the streets, it is not uncommon for the young men of

their acquaintance, who amuse themselves with training these birds, to give them a signal, which they understand, and immediately they bring the pieces of gold from the foreheads of the women in triumph to their masters. But, perhaps, my dear, some of the statements thus made may be a little coloured by the fancy. Do you recollect any satisfactory proof that the loxia or Indian sparrow uses glow-worms to light up its nest?

Mr. E. Yes. A gentleman, long resident in India, says, "Taking advantage of the absence of the birds, about four o'clock in the afternoon, I directed a servant to prevent their return, while I examined their nest, which I cut open, and found in it a full-sized glow-worm, fastened to the inside with what is in India called *morum*, a peculiarly binding sort of clay. Having sewn up the division, I replaced the nest; which, on the following evening, I again examined, and found another smaller-sized glow-worm, with fresh clay, a little on one side of the former spot. I subsequently tried the experiment on three other nests, in two of which the same results appeared, and in the third, the fresh clay was fixed, but no glow-worm. That the insect is placed in the nest as food, is, I think, rendered extremely doubtful by the fact of its being fixed in the clay, a useless labour for that purpose; and from the little likelihood there is that a bird, which, as I believe, never quits its nest

after roosting, which delights in sunshine, and which is never known to take any food during the night, should be of such a greedy disposition as to be unable to retire to rest without providing food for a future occasion."

E. I should think that gentleman must be right, papa; the sparrow does not stick the glow-worms up to eat, but he puts them in the clay because he does not like to go to bed in the dark.

F. Papa! I have often read of the bright shining of the sea, will you be so kind as to tell us how it happens?

Mr. E. I am glad you proposed that inquiry, Frederick, for the fact you mention ought not to be overlooked. In the voyages and travels, lately edited by Mr. Montgomery, it is said, "The brilliancy of the sea this evening far surpassed what we had hitherto seen of the kind. The ship was going rapidly along, throwing up a furrow of foam about the bow. In this the luminous appearances glistened with peculiar delicacy; but it was after the foam had subsided in the frothless water (itself of a deep-black hue), that they displayed their full splendour, gliding, like millions of diamonds, in giddy succession, by the side of the vessel, or flashing in her wake."

E. That must be beautiful indeed; what makes it so, papa?

Mr. E. It is ascribed by some to the night-shining-

nereis, multitudes of which inhabit every sea. They are found on all kinds of marine plants; but often leave them and swim on the surface of the water. So minute are they, that a small cup of sea-water will contain thousands on thousands. "I have observed," says Barbut, "a fish just caught out of the sea, whose body was almost covered with them, and have examined them in the dark. They twist and curl themselves with amazing agility, but soon retire out of our contracted sight; probably on account of their glittering numbers dazzling the eye, and their extreme minuteness eluding our search."

F. They seem very likely, papa, to produce the brightness. Do you know of any other cause?

Mr. E. The great traveller, Humboldt, was of opinion that though it arises in this way sometimes, yet at others it is owing to parts of dead mollusca, or animals which are without shells, and have tentacula or arms; these creatures abound beyond all calculation in the waters. He proved this by passing some of the bright water through cloth, when some of them appeared in the form of luminous points; though afterwards he thought it might be owing to a gelatinous or jelly-like substance produced from dead bodies, and which gives to sea-water a nauseous taste. Water, too, may thus be rendered luminous by throwing into it a quantity of herring brine.—It is not improbable, however, that many causes may contribute to this effect, of

which the poet Crabbe has said, as he described the splendour of the waves :—

> " Cast but a stone, or strike them with an oar,
> And you shall flames within the deep explore ;
> Or scoop the stream phosphoric as you stand,
> And the cold flame shall flash along your hand ;
> When, lost in wonder, you shall walk and gaze
> On *weeds* that sparkle, and on *waves* that blaze ! "

Mamma, do you recollect any thing else appropriate ?

Mrs. E. No, my dear.

Mr. E. Then we must pause for the best possible reason.

> " Words learned by rote, a parrot may rehearse,
> But talking is not always to converse ;
> Not more distinct from harmony divine,
> The constant creaking of a country sign."

THE BOAT-BUILDERS.

"Come, papa, and mamma, and Emma," said Frederick, as he just looked into the room, holding the door in his hand:—"Tom Hudson has got the boat ready; and I can pull too,—and when you like we can put up the sail. And the sun is so bright,—and the meadows and hedges so green,—and there's such a nice breeze! How we shall enjoy it!"

The request thus urged, with a countenance all animation and vivacity, was immediately granted; and the domestic party were soon down the flight of steps, over the lawn, and along the lane a little to the right, where Tom was waiting in his nice new boat, called "The Prize," from his having won it at a recent regatta. All were quickly seated, and most delightfully did they glide along; when, as Frederick was wondering at what rate they were going, Mr. Elwood asked if he ever heard of a boat which would never fill with water, even when exposed to the violent torrents which frequently accompany a thunder-storm?

"I have read of the life-boat," said Frederick.

"The life-boat," said his father, "is truly valuable;

it is the result of much skill and perseverance: but I am thinking of one which is made, not by man, but inferior creatures, and is the result of instinct rather than intelligence."

"I never yet heard of that," replied his son, "and as you, papa, know every thing, how pleasant it will be for Emma and myself to hear all you can tell us; and, though mamma has heard it before, I think, for our sakes, she would like it again."

"I should be quite as delighted as yourselves, my dears," was Mrs. E.'s prompt and kind reply.

F. But, papa, you have not told us yet who this famous boat-maker is.

Mr. E. The gnat,* my dear.

E. What, papa! the disagreeable little creature that bit my neck some time ago?

Mr. E. The same, my dear. The poet Rogers has given an animated sketch of its sanguinary movements, when he describes himself as dreaming "by the green-wood side, at summer eve:"—

> "'Tis thine to range in busy quest of prey,
> Thy feathery antlers quivering with delight,
> Brush from my lids the hues of heaven away,
> And all is solitude, and all is night!
> Ah! now thy barbed shaft, relentless fly,
> Unsheaths its terrors in the sultry air!

* Culex pipiens.

No guardian sylph, in golden panoply,
Lifts the broad shield, and points the glittering spear,
Now near and nearer rush thy whirring wings,
Thy dragon-scales still wet with human gore,
Hark! thy shrill horn its fearful larum flings!
I wake in horror, and "dare sleep no more!"

The instrument which the gnat employs is, however, very complicated and amusing? Did you ever see a set of lancets?

F. Yes, papa; when Mr. Ferguson called, he took a little case of surgical instruments out of his pocket, and showed me what was inside.

Mr. E. Such, then, is the tongue of a gnat: it consists of five pieces, and is shut up in a case, which is split from one end to the other, and gives steadiness to the instrument whenever it is used. It is not this, however, which causes the irritation, but it is occasioned by a fluid, which the gnat injects or throws in, to render the thick blood sufficiently thin to be sucked up through the trunk, or case, we have before spoken of.

F. That is very singular. Does the gnat undergo changes, like the butterfly?

Mr. E. O yes; the larva, or grub of the gnat, inhabits the water, and is therefore called aquatic. It usually swims near the surface of the water, with its head downwards, and its tail in the air, for a purpose which will presently be obvious. It may be met with in abundance during summer, in ditches, or in

water-butts, appearing like a minute, whitish, semi-transparent shrimp, or fish, when its body is a little bent, as it frequently is. Its organs for breathing are situated in the tail, a tube for which goes off from the last ring of the body, and both of these end in a sort of funnel, composed of hairs, in form of a star, anointed with oil, so as to repel water. Swammerdam remarks, that when, by handling it too roughly, this oil is removed, the grub "can no longer suspend itself on the water; I have observed it put its tail into its mouth, and afterwards draw it back, as a water-fowl will draw its feathers through its bill to prepare them for resisting water. When it wishes to descend to the bottom, it folds up the hairs of the funnel, but by means of its oil retains at their ends a globule of air; and, when it wishes to arise, it has only to open its hair funnel again." Its metamorphosis into a winged fly is very curious.

E. Every thing you explain to us is so, papa; who would have thought that such a little teasing creature was so wonderful?

Mr. E. When it is prepared to change its element, the insect rises to the surface, the body is divided, and, as soon as the aperture is large enough, the head of the gnat appears in its perfect shape; and then the animal, which has been hitherto aquatic, has nothing to dread so much as the water; for as yet its legs and wings are soft, moist, and bound up, so that they can be of

no use, and, were the water to touch its corslet, it would certainly and instantly perish.

F. Ah! there's no life-boat for a gnat!

Mr. E. Not by Captain Manby, my dear, but one has been provided in itself by the great and beneficent Creator. For, as soon as it puts its head out of water, it raises itself almost perpendicularly, and literally becomes a canoe, of which its own body forms the mast and sail. The skin floats, and when the observer perceives, says Reaumur, how much the prow of the little bark sinks, and how near its sides are to the water, he forgets at the moment that the gnat is an insect which at another time he would kill; nay, he becomes anxious for its fate, and the more so if the slightest breeze play on the surface of the water; the least agitation of the air suffices to waft the creature with swiftness from place to place, and make it spin round and round. Its body, folded in its wings, bears a greater proportiou to the little skiff, than the largest mass of sail to a ship: it is impossible not to dread lest the insect should be wrecked; once laid on its side in the water, there is no escape. Multitudes, indeed, thus perish, but generally all terminates well, and the danger is over in a minute. After having stood erect, it draws out its two fore-legs, and, bending to the water, places them on its surface, which is firm ground for a gnat's weight, and then all is safe; the wings dry and expand, and

the insect, quitting the water, where it was born, rises into the air.

F. Are there many of these wonderful little creatures?

Mr. E. It is supposed that from the end of May to that of October, six or seven generations are born; and each gnat is able to lay two hundred and fifty eggs. Indeed, were they not devoured by fish, water-fowl, swallows, and other animals, the air would often be darkened from their immense multitudes, so that though they only tease and annoy us now, they would become a sort of plague. So numerous were they in 1736, that vast columns of them were seen to rise in the air from Salisbury cathedral, resembling at a distance columns of smoke, so that many thought that fine building was on fire. A similar occurrence produced the same effect at Sagan, in Silesia, in 1812. At Norwich, in the following year, the inhabitants were alarmed by the appearance of smoke issuing from the upper window of the spire of the cathedral, which most probably arose from the same means. And in 1766, they appeared at Oxford, in the form of a thick black cloud, darkening the air. Six columns of them were observed to ascend from the boughs of an apple-tree, to the height of fifty or sixty feet; and their bite was exceedingly envenomed.

F. Why, papa, they are as bad as the mosquitoes of which I was reading yesterday.

Mr. E. The mosquito is only a large variety of the common gnat. It is found abundantly in the woody and marshy parts of all hot climates; and throughout Lapland, Norway, and Finland, and other countries equally near the pole, during their short summer. Can you remember, Frederick, any proofs of their ravages?

F. I think I can, papa. It is said that Sapor, king of Persia, was compelled to raise the siege of Nisibis by a plague of gnats, because they attacked his elephants and beasts of burden, and so caused the rout of his army. In the polar regions they are very terrible, for they seem able to resist any degree of cold, as well as to bear any degree of heat. Sometimes in Lapland they are compared to a flight of snow when the flakes fall thickest, or to the dust of the earth. And—and——

Mr. E. That will do, my dear; mamma has just been reading Clarke's Travels, and will tell us what is stated by that eminent traveller.

Mrs. E. He informs us, that in spite of gloves, clothes, and handkerchiefs, the bodies of himself and his companions became one entire wound, and that the irritation and swelling excited much fever. On a most sultry night, when exhausted by pain, heat, and fatigue, he sought refuge in his carriage, he could not venture to open a window, though almost suffocated. Still swarms entered his hiding-place, and, though he

had bound up his head with handkerchiefs, filled his mouth, nostrils, and ears. At length he succeeded in lighting a lamp, which was instantly put out by such a prodigious number of these creatures, that their carcases actually filled the glass chimney, and formed a large conical heap over the burner.

Mr. E. Thank you, my dear; now perhaps Frederick can relate how the Laplanders contrive to keep them out of their huts?

F. They burn a fire throughout the day, and, to defend themselves while in bed, the Laplander fixes a leathern thong to the poles of his tent, over his bed, which raises his canvas quilt to a proper height, so that its sides or edges touch the ground; under this he creeps, and passes the night in safety. So loud is their buz as to disturb, almost as much as their bite, the rest of persons exposed to their attacks. The more wealthy inhabitants of climates where they abound, usually sleep under nets of gauze.

E. Papa, you said just now that before the gnat began to fly it became a canoe; was this all you meant, when you said it was a boat-builder?

Mr. E. No, my love; when the female gnat has laid her eggs she makes of them a little boat. Each egg is shaped like an olive or a powder-flask, and, by itself, would sink to the bottom of the water; yet the gnat puts the whole three hundred together so skilfully that they all swim on the surface, safe and

unhurt, until the larvæ, or grubs of the gnats are hatched.

E. It is very surprising, papa, that so large a number should float, while one would go to the bottom of the pond. But I think you will let us into the secret.

Mr. E. A gnat has six legs; the four fore-legs she rests on a floating leaf, or on the side of a bucket, if she is in water contained in such a vessel; and her body is thus held level with the water, except the last ring of her tail, which is a little raised. She then begins to use her two hind-legs, which she crosses in the shape of the letter X, the open part of which, next the tail, serves as a kind of scaffold for the eggs she lays, until the boat is nearly formed. Each egg, when laid, is covered with a sort of glue; the gnat holds the first-laid egg in the crossed legs until the second is placed by its side, and fastened to it; she then glues to these another egg, making a triangle, or three-sided figure; and this is the beginning of the boat. Thus she goes on piling egg upon egg, always keeping the boat in proper shape by her useful hind-legs; and, as it grows in size, she pushes it from her by degrees, still adding to the unfinished end next her body. When the boat is half built her hind-legs are stretched out like two parallel lines; she has no longer need to cross her legs; and she holds up the boat as cleverly as if it were done with two outstretched arms.

F. And is it much like a boat, papa?

Mr. E. Yes, my dear, it possesses not only the form, but also most of the other properties of a boat; its fore and hind parts being sharper and higher than the middle; the lower part on which it always floats being convex, and the upper part concave. It is likewise so buoyant, that no agitation of the water, however violent, can sink it; and, what is still more deserving of admiration, although hollow it will not sink. Mr. Kirby says, "To put this to the test, I put half a dozen of these boats upon the surface of a tumbler, half-full of water. I then poured upon them a stream of that element, from the mouth of a quart bottle, held a foot above them. Yet, after this treatment, which was so rough as actually to project one out of the glass, I found them floating as before on their bottoms, and not a drop of water within their cavity.'

E. I wonder, papa, if any other insect builds such boats!

Mr. E. I do not know of one; but in the fen ditches of Norfolk a large spider has been found, which actually forms *a raft*, for the purpose of obtaining its prey more easily. It first makes a ball of weeds about three inches in diameter, and, taking its place on this floating island, it pounces on a drowning insect the moment it is seen; not, of course, to aid its escape, but to hasten its destruction. The body

thus secured is then conveyed on the floating raft, where it is devoured at leisure. But, Tom, bear now to the land; we will just walk through these fine fields to the pretty white cottage, and then we will return and sail all the way home.

OPTICS.

"Emma and Frederick," said Mr. Elwood, "I want to converse with you about something very curious."

"What is it, papa?" said Emma.

"That is what I wish you and your brother to tell me," replied her father.

"O papa," replied Emma, "there are so many curious things! What a number you have told us of! How shall we know which to take?"

"I will give you a clew, then," said Mr. Elwood. "What are those things of which some people have one and others have none;—which those who have not cannot buy, and those who have cannot sell;—which those who possess carry wherever they go, and yet never see;—which are as useful to the king as to the peasant, and yet neither can tell their full value;—which can be thrown a great way, and at the same time be kept in their place;—which are so small that they may be covered with a finger, and so large as to include a tree, a house, a mountain, a town;—which are so skilful as to find out many a secret, and yet

not clever enough to prevent others being disclosed;—which——but I have told you enough."

Frederick looked at his mamma, who smiled at his anxiety, but did not give him a hint which could enable him to unravel the mystery; and Emma seemed all effort though in vain, until she jumped up from her seat in extacy, saying, "I know—I know, papa, what you mean—it is a pair of eyes!"

"You are quite right, my dear little girl," said her father; "and we will presently examine one of these wonderful things more particularly. But light, the great medium of vision, is also very marvellous, and deserves previous notice. Try and remember its general properties, which have been discovered by observation and experiment:—It is sent forth in all directions from every visible point of luminous bodies; all bodies not luminous of themselves, are rendered visible by light derived from those which are luminous; natural or artificial bodies throw off light *of the same colour* as themselves, although the light of the sun which renders them visible *is white.* Light consists of separate parts independent of each other: the smallest part which can be stopped, or allowed to pass, is called a ray; rays of light proceed in straight lines, and light moves with prodigious velocity,—that of the planets travelling at the rate of 195,000 miles in a second of time! From many I select one other amazing fact. You have seen an instrument called a magnet,

which would attract and take up pieces of iron and steel; and you have heard that light partakes of all the colours of the rainbow. Now, it was thought twenty years ago, that the *violet* rays had the property of communicating *magnetism*, and this has been lately established. The indigo rays produced nearly the same effect; and the blue and green rays produced it in a less degree; but the others exhibited no magnetic influence. Having mentioned these things, look at that part in the centre of my eye; it is called the pupil, and round it is a coloured border, named the iris; now the rays of light which come from any object enter at the pupil of the eye, and go on to what is called the retina, or optic nerve, which is placed at the back of the eye-ball, is of a most perfect whiteness, and proceeds from the brain. To show you this more clearly, I will close the shutters, in which I have placed a lens, or glass, of which there are many different kinds, and only admit the light through it into this room. Now look, opposite the opening you will see a picture on the wall—of the garden, the trees waving in the wind, and the boy with the wheelbarrow; in fact, a miniature picture of what is on the other side of the shutter, and which would be quite perfect were it not upside down—the sky being beneath and the ground above; and just such a picture is painted on the retina of the eye.

F. But, papa, is it upside down there?

Mr. E. It is, my dear; the reason of its being so I must give you when I can explain the science of optics to you more fully; I would now only remark, that experience teaches us to form correct ideas of things. Whenever you look at an object, a picture of it is thus painted on the retina, which conveys the idea to the mind. Observe, further;—in a faint light the pupil expands so as to admit more rays, and in a strong light it contracts, to prevent the injury of the optic nerve. Frederick, look at your sister's eyes, as she sits near the window; the pupils are small, and the iris large. Now, Emma, turn from the light, and cover your eyes for a few moments with your hand: and thus the light being shut out, the pupils are enlarged, and the iris diminished. Here, then, is a little wonder, and what man would find great difficulty in making—*a circle continually altering its size, and yet always preserving its form.* Another contrivance of the all-wise Creator is equally extraordinary:—it is one by which the eye sees at the same time what is near and what is distant. Now, Emma, take the telescope, which is a very curious optical instrument, and move the tube, until you see quite distinctly the tree at the side of the great gate; then, without altering the tube, direct the telescope towards the church on the hill; but that will be very obscure, because the glass, adapted to what is near, is not

suited to what is far off. How this alteration takes place in the eye has only been discovered of late. It is now found that, by what are called "straight muscles," three changes are at the same time produced in the eye, which effect all that is necessary. It appears, too, that the different natural magnifiers of the eye are combined, just as the glasses are in the celebrated telescopes of Mr. Dolland, who devoted many years to their construction and improvement. Thirty years later, Mr. Blair found that their imperfection was still further corrected by combinations of different liquids; and, wonderful to tell, when the eye is examined, we find it consists of different liquids, acting naturally on the very same principle which was thus recently discovered after many mechanical and chemical experiments.

F. Most astonishing, indeed!

Mr. E. Every part of the eye is so. How tenderly and carefully is it protected! It is placed in a strong, deep, bony socket, formed of seven different bones, hollowed out at the edges; within this it is imbedded in fat—the best thing adapted to its motion and repose; and it is sheltered by the eye-brows to prevent any moisture from running into it. It is still better defended by the lid, which wipes it, and closes it in sleep. It is supplied with a lotion to wash it, for the discharge of which, when used, a hole as large as a goose-quill is made through the bone of

the nose. A slight deficiency would produce great inconvenience. Thus I have read of one gentleman who was, as to the rest, in pretty good health, but wanting the *two little muscles* that serve to lift up the eye-lids, and having almost lost the use of his sight, was compelled to lift them up every moment with his hands, so long as the defect lasted, and was consequently in circumstances truly pitiable.

Mrs. E. The eyes of the chameleon are very singular, being covered with a rough membrane, which is attached to the eye-ball, and follows all its motions. This membrane is divided by a narrow, horizontal slit, through which the bright pupil, as if bordered with burnished gold, is seen. This wonderful structure greatly resembles the artificial defence employed by the Laplanders, and other northern people, for defending their eyes against the excessive reflection of light from the surface of the snow, by means of a narrow slit in a hollow piece of wood. Here, then, art coincides with nature; but imitation is not likely to have happened, as the chameleon is a native of warm climates. The eyes, too, can look in different directions at the same instant. One of them may be frequently seen to move when the other is at rest; or one will be directed forward, while the other is attending to some object behind; or in the same manner upward and downward.

Mr. E. The eyes of birds deserve particular

attention. As they generally procure food by the beak, and the distance between the eye and the point of the beak is small, it is necessary they should see very distinctly whatever is near; and then, as they often rise far above the ground, live in air, and move through it with great speed, they need, for their safety, as well as for descrying their prey, a power of seeing at a great distance, of which, in birds of prey, surprising examples are given. Now, marvellous as it is, the eyes of birds are so contrived, that they are adjusted with more ease and readiness than those of other animals. To keep the surface of the eye clean, and to protect it, without hindering the sight, while rapidly flying through the air and through thickets, birds have a *third eye-lid*, a fine membrane, or skin, which is constantly moved very quickly over the eye-ball by two muscles placed in the back of the eye. One of the muscles ends in a loop, the other in a string which goes through the loop, and is fixed in the corner of the membrane to pull it backward and forward—a contrivance which is proved to be the best for obtaining the quickness required.

Mrs. E. What a contrast is there in the eyes of the mole! It wants some light, and yet a large and prominent eye could not easily have been guarded while the creature worked its way under ground. To meet these difficulties, then, it has eyes, but they are scarcely larger than the head of a large pin, and even

these are sunk so deeply in the skull, and lie so sheltered within the velvet of its covering, as that any contraction of what may be called the eye-brows, not only closes the openings to the eyes, but forms a cushion, as it were, to any sharp or projecting substance which might push against them. Even in its usual state, the opening is like a pin-hole in a piece of velvet, which loose particles of earth could hardly enter. The horse, like birds, has a third eye-lid, called the *haw*, which is moistened with a pulpy substance, or mucilage, to take hold of the dust on the eye-ball; so that the eye is hardly ever seen with any thing on it, though, from its position and size it is much exposed.

E. Now I see how I can puzzle somebody, though not papa and mamma, who always get over things so nicely; nor Frederick, because he knows it, though I do puzzle him sometimes;—I'll ask, why is a horse like a bird?—and when they have tried a good long while, and then can't tell, I'll say, because it has a third eye-lid. Is not that a good riddle?

Mr. E. It is certainly one, my dear, which every body cannot solve; however, you may make the experiment. The eyes of fishes are fully adapted to the element in which they live; and in certain respects differ from the eyes of other animals. In the eel, for instance, which has to work its head through sand and gravel, there is placed before the eye, and at some distance

from it, a transparent, convex case, or covering, which defends the eye, without obstructing the sight. One thing, however, is common to almost all eyes, if not quite all—the optic nerve enters the bottom of the eye, not in the centre or middle, but a little on one side, and why?—*That no part of an object may be unseen by both eyes at the same time.*

Mrs. E. We may now, I think, attend a little to the eyes of insects, which include, as Kirby says, "a world of wonders." Some eyes are called *simple*, and vary as to number from two to sixteen. In many they are imbedded, as usual, in the head; but in a little scarlet mite they stand upon a small foot-stalk, that the hairiness of this animal might not impede its sight. Other eyes are called *conglomerate*, because they are collected into a body; thus, in the common millepede, there are twenty-eight of these eyes, placed in seven rows, and forming a triangle, at the bottom of which are seven, and at the top one. Others are denominated *compound*, and when seen under a microscope, they seem to consist of an infinite number of convex hexagonal, or six-sided, pieces. The eye of the hive-bee, for instance, is very curious. The outer coat is stiff, hard, flexible, and transparent, similar to a very thin plate of horn. It is not smooth, as in men and other animals, but divided by various and manifold divisions, which somewhat resemble little globes; and hence Dr. Hooke and others supposed

that the insect's eye was an innumerable multitude of little eyes. The divisions, however, are rather six-sided, exactly like the closed cells of the comb, or like a little net. The eyes of the bee are very thickly covered with hair, serving, as is supposed, instead of eye-brows or eye-lashes; the hairs resembling bristles, being round, and tapering from the root to a fine point. Their number is very considerable, and they appear so closely set as to constitute a thick forest of bristles, like so many fir-trees planted upon the eye; and are probably intended to keep it from annoyance or injury.

Mr. E. Puget adapted the eye of a flea so as to view objects through it by means of a microscope, and the sight was very singular. A soldier who was seen through it appeared like an army of pigmies; for, while it multiplied, it also diminished the object; the arch of a bridge exhibited a spectacle more magnificent than human skill could produce; and the flame of a candle seemed the illumination of thousands of lamps. Leeuwenhoek looked through the eye of a dragon-fly in the same way, and viewed the steeple of a church, which was 299 feet high, and 750 feet from the place where he stood. He could plainly see the steeple, though not apparently larger than the point of a fine needle. He also viewed a house in the same manner, and could discern the front, distinguish the doors and windows, and perceive whether they were

open or shut. Dr. Hooke computed that there were 14,000 of these lenses in the two eyes of a drone; and Mr. Leeuwenhoek reckons 12,544 lenses in each eye of the dragon-fly. The pictures of objects, therefore, that are delineated on these, must be millions of times less than those formed on the human eye. Many insects still smaller have eyes, doubtless, contrived to see objects thousands of times less than themselves; for such the small particles on which they feed must certainly be.

E. O papa, papa, it's wonderful, most wonderful! And so an insect's eye is something like my multiplying glass.

Mr. E. It is; and one that was in action for ages before any of the lenses and glasses of the optician. The facettes, or sides, resemble a brilliant cut diamond, of which 17,325 have been counted in the eye of a butterfly. The eyes of all insects have this peculiarity—they are immoveable; and those which have occasion to see both above and below the head, have them placed so that they can do this. Though they have no iris or pupil, some of them are very beautiful. "Look," says Kirby, "at those of one of the lace-winged flies, that commit such havoc among the aphides (or plant-lice), and it will dazzle you with the splendour of the purest gold, sometimes softened with a lively green. The lenses of those of Xenos blaze like diamonds set in jet." The fiery eyes

of many horse-flies have vivid bands of purple and green. Others are spotted; and one has the figure of a flower painted in red on a black ground.

Mrs. E. The wonders of the eyes of insects surpass all imagination: how many, my dears, have been related already!—yet the whole has not been told. What would you say were I to tell you of others?

F. I should like you to do so very much, mamma; but I can't tell you what I think of these things—they are so very—very marvellous.

Mrs. E. Some spots are often found on insects, frequently placed in a triangle, and these are real eyes: and it is supposed that the compound eyes have the power of magnifying much, and these simple ones the power of magnifying little; so that the former are for seeing what is distant, and the latter what is near. Well might Kirby, say, "Let us here stop and adore the goodness of a beneficent Creator, who, though he has deprived these little beings of the *moveable* eyes with which he has gifted the higher animals, has made it up to them by the variety and complex structure of their organs of vision; where *we* have only *two* points of sight, giving *them* more than as many *myriads*.

THE AERONAUTS.

It was a September morning, and the aspect of nature was autumnal. The foliage of the trees had begun to change their hue; and, while the orchards yielded their last fruits, which might grace the dessert of a peer, the hedges were filled with their humble produce, and clusters of privet, elder-berries, and buckthorn, vied with one another. These, however, were relieved by the hips, honey-suckles, and viburnum, which put forth their scarlet balls; and the beautiful fruit of the woody night-shade, wild-service, and mountain-ash delighted the eye, and soothed the spirits depressed by the anticipation of winter.

Of this Mr. Elwood felt conscious, when, returning from an early call on a friend, he saw his youngest child, Edward—a fine boy of four years old, whose clustering locks, bright eyes, and rosy cheeks, made him a model of infant beauty—blowing soap-bubbles, with many a clapping of hands, and merry bound, and hearty laugh, as he saw them rise, glitter, and at length burst in the air. Amused at the sight, he gazed for some time; when, calling Emma and

Frederick, he told them to watch the process, and that the first balloons ever made were produced in a similar way. This led to many inquiries, and to the remark, that what has been done only of late years, after many efforts, by man, to rise into the air, has been accomplished, from the earliest times, by the gossamer spider.*

"O, papa!" said Emma, on hearing this, "I wish you would tell us all about them. Now, I think you will!—and here, dear mamma, let me place your chair next to papa's, and you can remember something;—and I will listen so attentively, and Frederick will—won't you, dear? And then, mamma, and then—I'll play my new rondo as well as ever I can."

Mr. E. Happily, my dear, I have leisure to gratify you. Dr. Lister noticed the falling of these webs, and in them discovered more than once a spider, which he named the *bird.* On one occasion, whilst he was watching a common spider, it suddenly turned on its back, darted forth a long thread, and, vaulting from the place where it was, was carried upwards to a great height. He further discovered that, while spiders fly in this manner, they pull in their long thread with their fore-feet, so as to form it into a ball—or, as it may be called, air-balloon—of flake. So high did they ascend, that one day in autumn, when the air was full of webs, he went to the top of the

* Aranea obtectrix.

highest steeple of York Minster, from whence he could see the floating webs still far above him. He took some of the spiders that fell and were entangled on the pinnacles. They were of a kind that never enter houses, and, therefore, could not be supposed to have taken their flight from the steeple. Of one insect he observed, he says, "Certainly this is an excellent rope-dancer, and is wonderfully delighted in darting its threads; nor is it only carried in the air like others, but it effects itself its ascent and sailing: for by means of its legs, closely applied to each other, it as it were balances itself, and promotes and directs its course no otherwise than as if nature had furnished it with wings or oars."

F. Has any other person particularly noticed them?

Mr. E. Mr. White has done so. "Every day in fine weather in autumn," he says, "do I see these spiders shooting out their webs and mounting aloft; they will go off from the finger if you will take them into your hand. Last summer one alighted on my book as I was reading in the parlour; and, running to the top of the page, and shooting out a web, took its departure from thence. But what I most wondered at was, that it went off with considerable velocity in a place where no air was stirring; and I am sure that I did not assist it with my breath. So that these little crawlers move faster than the air in the air itself."

E. Are they often to be seen, papa?

Mr. E. Yes, sometimes in great numbers. I will give you Mr. White's account of a shower of these webs. On the 21st of September, 1741, intent upon field diversions, he rose before day-break; but, on going out, found the whole face of the country covered with a thick coat of cobweb drenched with dew. When his dogs attempted to hunt, their eyes were so blinded that they were obliged to lie down and scrape themselves. About nine o'clock a shower of these webs, formed not of single floating threads, but of perfect flakes, some near an inch broad, and five or six long, was observed falling from very high regions, which continued through the whole of the day; and they fell with a velocity which showed that they were considerably heavier than the atmosphere. On ascending the highest parts of the country where this was observed, the webs were still seen falling, and twinkling like stars in the sun. The flakes of the web hung so thick upon the edges and trees, that baskets-full might have been collected. In Germany, these flights of gossamer appear so constantly in autumn, that they are there called "the flying or departing summer;" and authors speak of the web as often hanging in flakes, like wool, on every hedge and bush, throughout extensive districts.

F. For what are these webs made, papa?

Mr. E. As the single threads shot by other spiders are usually their bridges, this, perhaps, may be their

object, and thus the spiders may be conveyed from spot to spot with less labour than if they had travelled over the ground. And, as Kirby says, also, as they seem so thirsty, may not the drops of dew with which they are always as it were strung, be a secondary object with them? So great are their numbers, that sometimes every stalk of straw in the stubbles, and every clod and stone in the fallows, swarms with them. Dr. Strach assures us, that twenty or thirty often sit on a single straw, and that he collected about two thousand in half an hour, and could have easily doubled the number had he wished it.

E. But, papa, what makes the spiders go up, up, up, like Mr. Green's balloon, which I saw at Stamford, until it looked not larger than an orange, and then went quite out of sight?

Mr. E. It is probable that they do so in pursuit of food, for the rejected parts of gnats and flies are often found in the falling webs. Perhaps the flight of some particular species, forming a favourite food of the little aëronauts, may take place at these times. No doubt, however, that the end is worthy such extraordinary means. And I wish you particularly to observe, when you see this spider's thread floating in the air, and stretching from hedge to hedge across a road or brook of four or five yards wide, that this little creature has *no wings* wherewith to fly, nor muscles to enable it to spring or dart to so great a

distance; and hence its Creator has laid for it this path in the atmosphere. Though the insect itself be heavier than air, the thread which it spins is lighter. This, then, is its *balloon*. Left to itself, the spider would drop to the ground; but, being tied to its thread, both are supported! This also mounts, and buoys up the insect itself, as the tail of a kite does the body. Some of them, it seems, not only bestride their film, but roll it up in a mass, and then sail in a balloon.

Mrs. E. My love, the web of the gossamer spider finely illustrates Paley's doctrine of compensation. It supplies the place of wings; and the defects of one part or of one organ are often made up for by the structure of another part or of another organ. Let us try to recollect some instances. I remember, he says, that the common parrot has, in the structure of its beak, both an inconvenience and a compensation for it. By an inconvenience, he means, what appears when the peculiar structure of an organ which fits it for one purpose unfits it for another. Thus the upper bill of the parrot is so much hooked, and so much overlaps the lower, that if, as in other birds, the lower part alone had motion, the bird could scarcely gape wide enough to receive its food; yet this hook and overlapping of the bill could not be spared, for by it the bird climbs: to say nothing of its use in breaking nuts and the hard substances on which it

feeds. How, therefore, is the difficulty prevented?—By making *both* parts of the jaw moveable. In most birds, the upper chap is connected, and makes but one piece with the skull; but, in the parrot, the upper chap is joined to the bone of the head by a strong membrane placed on each side of it, which lifts and depresses it at pleasure.

E. That's a delightful story, mamma; perhaps, while you are thinking of another, papa will tell us what he remembers.

Mr. E. Birds have no teeth;—I mean such as common fowls, pigeons, ducks, geese, &c. What have they, then, to make up for this want?—A most powerful muscle called a gizzard, the inner coat of which has rough plaits, which, by strong friction against one another, break and grind the hard food as effectually, and by the same sort of action, as a coffee-mill would do. Without this, it is proved that a chicken would starve upon a heap of corn! This contrivance goes no farther than the necessity. The food of birds of prey does not require to be ground in a mill, and in them a gizzard is not found. I almost forget what he says about the bat.

Mrs. E. I remember it perfectly. At the angle of the bat's wing there is a bent claw, exactly in the form of a hook, by which the creature attaches itself to the sides of rocks, caves, and buildings, laying hold of crevices, joinings, chinks, and roughnesses.

It hooks itself by this claw, remains suspended by this hold, and takes its flight from this position; which compensates for the shortness of its legs and feet. Without its hook, the bat would be the most helpless of all animals. It can neither run upon its feet, nor raise itself from the ground. But all this is made up for by the contrivance on the wing; and, in placing a claw on that part, the Creator has deviated from what is observable in winged animals. "A singular defect," says Paley, "required a singular substitute."

F. Cannot you give us one more such fact, papa?

Mr. E. Yes, my dear, but that one must suffice. The short, unbending neck of the elephant is made up for by the length and flexibility of his proboscis or trunk. He could not reach the ground without it; or, if he could have fed on the fruit, leaves, or branches of trees, how was he to drink? Should it be asked, why is the elephant's neck so short? It may be answered, that the weight of a head so heavy could not have been supported at the end of a longer lever. And then the proboscis itself is most curious. The disposition of the rings and fibres —first, to form a long pipe; secondly, to contract and shorten it; and, thirdly, to turn it in every direction at pleasure: with, moreover, a fleshy production at the end, of about the length and thickness of a finger, and performing the office of one, so as

to pick up a needle or a straw—exhibits an instrument truly amazing.

E. Wonderful—wonderful—wonderful, papa!

Mr. E. Yes, my love,

> "Wonderful, indeed, are all *His* works,
> Pleasant to know, and worthiest to be all
> Had in remembrance, always with delight."

THE UPHOLSTERERS.

"And now, Frederick," said Mr. Elwood, "as you wished me to save what I was going to say about the dew, in our morning walk, until we reached home, and as we are all here, I will resume the subject. Sweet, indeed, is the breath of morn, and among its beauties are the bright round drops of dew which rest on every leaf and blade of grass, and shine in the sun-beams like so many diamonds. As the sun rises, they begin to disappear, and the leaves and grass become dry. When the day is hot, the earth, cool and moist in the morning, is parched and dusty; but, as the sun retires, the grass and leaves are again bedewed, and the earth is cool.

"And what is dew? It comes from the air;—it is condensed vapour. I will show you how it is formed. The urn, now on the breakfast-table, contains boiling water—see, some steam escapes, it mixes with the air, and is lost. But mark, I will place this wet napkin round the outside of the glass to make it cold, and into it I will let some of the steam go; and now you

perceive the steam is turned into water, and runs down the side of the tumbler.

"Whenever, then, the sun shines, it draws up water from the pools, ponds, lakes, rivers, and seas, from the surface of the earth, and even from the leaves of plants and the blades of grass, and that in the form of steam or vapour; but when the air becomes cool, the steam or vapour will become water again, and thus be turned into rain or dew.

"In a morning or evening walk you will see, that though the grass is wet, the footpath is dry; and, that though the hedges are covered with dew, the gate you have to open, or the stile you have to cross, is not;—how, then, is this?—The grass is colder than the path, and the hedges are colder than the gate or stile;—the one, therefore, condenses the vapour, and the other does not.

"When winter comes, every tree, bush, twig, and blade of grass, after having been stripped quite bare, puts on frequently a white and feathery garment; the hedges are covered with a snowy foliage; the woods are splendid and silent; every thicket assumes a strange loveliness; here and there the birds scatter the rime around in fleecy showers; and the mind of the observer, affected by the beauty of the scene, dwells alternately on the suddenness of the change, and on its speedy termination.

"Now, the hoar-frost is frozen dew. All things

out of doors become at that season excessively cold, and thus they not only cause water to settle on them in the form of dew, but freeze it also. I will show you some day some crystals of hoar-frost in a microscope; the figures they form are exceedingly various, and exquisitely regular and beautiful.

"And so, mamma, having fulfilled my promise to Frederick, I will now say, that after a delightful walk to the neighbouring town, we called on Sims, the upholsterer, stated your wishes, and obtained his promise to be here at seven o'clock to morrow morning, to do what you desire."

Mrs. E. Thank you, my dear; Emma and I found some interesting employment as well as yourselves; the garden and the fields are alike instructive.

> 'Tis well when aught can wake the heart
> To love, and faith whose trust is right!
> 'Tis well when the soul is not seared,
> And the low whisper can be heard
> That breathes through nature day and night!

E. Papa, I have just thought of a puzzle for *you.* You have told us about masons, and carpenters, and a great number of wise—very wise little creatures;—now, can you think of any one like Sims, who is coming to look at the tapestry, and to put up the new curtains?

Mr. E. Ah! you little rogue! Does it follow, because I can tell you something, I can tell you *every*

thing? And yet, I dare say you would enjoy it, were I now to look up to the ceiling, as you do sometimes, and say, "The upholsterers—the upholsterers!—dear, what can they be?" and especially were I then to add, "Emma, I must give it up." But I like to see you amused and happy; and I should not mind, I assure you, your innocent mirth. However, if at last I should be quite *posed*, I will allow you to laugh very heartily. Let us now talk a little about one kind of caterpillars. Each lives in a cell, which it begins to form just after it is hatched, and which is at once a house to defend it from its foes, and a store of food for its subsistence, while it remains in its prison. Most admirable is the skill with which it is prepared. To roll up the leaves for this purpose, as regularly as possible, might be thought a task if the caterpillars had fingers; but, though a leaf is difficult to roll, is often brittle, and is, moreover, inclined to spring back, the insect surmounts these difficulties, and so accomplishes its object that the leaf remains rolled up for many weeks.

E. What, then, papa, does it use instead of fingers?

Mr. E. The surface of a leaf appears flat at first sight, but, examined narrowly, some part of it will appear more or less curved, and, as soon as this is seen by the caterpillar, it begins, with great art and dexterity, to increase the curvature; and its head may

be seen moving like a pendulum from the edge towards the middle of the leaf. After two or three hundred of these movements, the part on which it has been working may be seen to be rolled up. This is done by means of little silken cords. If one be examined, it will be found, instead of being formed of parallel rows, to be composed of two sets which cross each other; the reason of which is variously explained. De Geer, as he watched one of these caterpillars, observed, that at each new thread it spun, the edges of the leaves gradually approached each other, and were bent more and more, as the caterpillar spun new threads; and, when the last-spun thread became tight, that which preceded it appeared loose and floating in the air. To do this, the caterpillar, after it has fixed a thread to the two edges of the leaf, and before it spins another, draws it towards itself by the hooks of its feet, and thus bends the leaf: it then spins another thread, to keep the leaf in this position, which it again pulls towards itself; and repeats the operation till it has bent the leaf in its whole direction. It now begins again, placing the threads further back upon the bent part of the leaf, and by proceeding in this manner, rolls it up. When it has finished this business, it strengthens the whole by fastening the ends of the leaf together. The habitation thus formed is a kind of hollow cylinder, open to the light at both ends, the sides of it yielding the caterpillar both food

and protection; for within it the insect feeds in safety. Here, too, it also undergoes its transformation; at the approach of which the creature lines the rolled leaf with *silk*, that the rough parts may not injure the tender chrysalis.

F. But, papa, suppose the leaf is thick and strong, how does it manage *then?*

Mr. E. It eats down a bit here and there of the nervous, or principal fibres of the leaf; and the parts thus consumed appeared to Reaumur to correspond in number and situation with those in which the leaf was to be curved in order to begin a new turn. The oak-leaf being deeply notched, its inequalities sometimes project so much, that it is difficult to bring them within the curve of the rest of the leaf, and these *we* should think of cutting off, but the caterpillar does what amounts to the same thing; it fixes what is superfluous with a thousand threads to the side of the leaf, and then works it with its head into a round form.

E. Papa, does it make more than one fold?

Mr. E. Yes, it proceeds to roll the leaf, until it has encased itself in four or five; and, in addition to the silken bands used to secure these folds lengthways, a couple are tied to one or both ends of the cylinder; yet so as to allow the insect to go out and return. Thus defended from its foes, it nibbles and consumes successively the layers which compose its case; so

that when the cell is examined, after a certain time, it is found to consist only of the outermost roll.

E. That is very funny, papa;—to make a house and then to eat it is an odd thing.

Mr. E. Did you never, hear, Emma, of a house being eaten before? I have heard of many.

E. What, papa, can timber, and bricks, and stones be eaten?

Mr. E. All houses, you know, are not formed of these materials. Some swallows-nests are edible. M. Valenciennes thinks that they are made of the branches of a fucus, common in the eastern seas; and M. Reinwardt supposes that whatever the bird employs is partly formed, or consolidated, by a glutinous fluid which it secretes. They are in repute for acting as a restorative. Some of the caverns in which they are found are difficult of access, and they can only be collected by persons accustomed to the work from their youth. The most remarkable and productive caves in Java are only to be approached by a perpendicular descent of many hundred feet, by ladders of bamboo and rattan, over a sea rolling violently against the rocks. When the mouth of the cavern is reached, the perilous office of taking the nests must often be performed with torch-light, by penetrating into recesses of the rock, when the slightest trip would be instantly fatal to the adventurers, who see nothing below but the raging surf making its

way into the chasms of the rock. The only preparation the nests undergo is that of simple drying, after which they are packed in boxes, usually of about 135 pounds. In the Archipelago this property is said to be worth £284,290.

E. Well! I never heard any thing like that. I shall be quiet, papa, when you speak of eating houses again. But there seems to be no end of your strange stories. Oh, I hope they will last till I am as tall as cousin Sarah, and Frederick is as big as you!

Mr. E. But we must not forget the leaf-rolling caterpillar. Having eaten itself out of house and hold, it sets about forming another dwelling; and the last it makes differs somewhat from the first, for it is larger in size, because the insect has grown more bulky. The leaf is not bent so much, and therefore does not offer the same resistance, of which the creature seems aware, as it makes its cordage not so strong. Instead of bending the leaf by many little cables, it spins a web which extends the whole length of the leaf. This web, like the cords already described, is formed of two sets of fibres; the first set acted on by the weight of the insect's body, draws the leaf downwards; the second secures the additional curve which has been thus gained in its proper place. Within this cylinder the caterpillar becomes a chrysalis, and a perfect insect. When about to enter the latter state, it gets rid of its chrysalid covering by the

efforts it makes to pass through the end of the cylinder: this being narrower than the body of the insect, scrapes off and retains the skin. An ingenious contrivance for escape was observed by Bonnet, in one of the leaf-rollers, which feeds on the leaves of young ash-trees. It rolls up the leaf into a cone, and is transformed into a small pupa, resembling a grain of oats. Within its capacious and compact chamber it hangs itself up by two lines, after the manner of a sailor's hammock. But, previous to this, it gnaws a circular piece *half through the leaf,* taking care not to injure the outer membrane. In order to render this little door easy to be found, the caterpillar, as if foreseeing that the blind pupa could not otherwise discover it, fixes one of the suspending threads near its margin guided by which the insect retires with the greatest ease, *for the head is always swung up by the door-thread.* How amazing the instinct by which these efforts are made! But it is time that I told you of another little acquaintance of mine—a bee.

E. Oh, papa, neither of us can be tired of the caterpillars! But then, perhaps, if you say much more about them, we shall hear very little about the bees—and I *love* bees.

Mr. E. The bee I mean, makes the outer wall of her nest of the wool of certain plants, such as rose campion, the quince, cats-ears, &c. "It is very pleasant," says Mr. White, "to see with what address

this insect strips off the down, running from the top to the bottom of the branch, and shaving it bare with all the dexterity of a hoop-shaver. When it has got a vast bundle, almost as large as itself, it flies away, holding it secure between its chin and fore-legs. The manner in which the nests are made seems not to be very clearly understood. M. Latreille says, that after forming her nest of the down of quince leaves, she lays her eggs, together with a store of paste, made of the pollen of flowers, for nourishing the grubs. Kirby and Spence tell us, on the other hand, that the parent-bee, *after* having constructed her cells, laid an egg in each, and filled them with a store of suitable food, plasters them with a covering, apparently composed of honey and pollen; and, having done this, aware, long before Count Rumford's experiments on the subject, what materials conduct heat most slowly, she collects the down from woolly plants, and sticks it on the plaster which covers her cells, and thus wraps them with a warm coating of down. Other opinions have, however, been formed; and future inquiry must determine which is right. I wish more particularly to tell you of one bee* belonging to this family.

She forms a cylindrical hole in a beaten path-way, or in the cavities of walls or decayed wood, and makes her nest there of leaves, sometimes taken from the

* Megachile centuncularis.

rose-tree, and at others from the birch, the perennial mercury, or the mountain-ash. It resembles a tooth-pick-case with its ends rounded in form, and is sometimes eighteen inches long. The shape of the cut pieces is either semi-ovoid, that is half-oval, or circular; and occasionally it makes a mistake in the size, as it were to show that it is not a mere machine. The pieces of leaf first used in lining the apartment are the largest; these it rolls into a tube, lining the whole length of the hole it has made, and rounding off and closing one end of it by doubling the pieces one upon another. Within this is made the number of cells which the insect requires. Three half-oval pieces of leaf, rolled so that the edge of one piece overlaps a little the edge of the next, form the hollow of the cell, its height being less than an inch. The ends of these pieces are then turned up to form the bottom; but the bee, not contented with one layer, thickens the lining by three additional pieces within it; and again within that by three others, so that there are at least three cells put one into another, each made of three pieces of leaves, the bottom of which, being formed of the turning up of the ends of them all, is nine-fold.

E. Indeed, papa, it's very surprising; but then you know this is the work of *a bee*, and what insect is more clever than my little favourite? But, what is done afterwards?

Mr. E. One cell being thus completed, an egg is laid within it, and the empty space around the egg is filled with food nearly liquid. The cell being placed horizontally, it is necessary to cork it up; and this the bee does by cutting several circular portions of leaf which exactly fit the mouth of the cell: they are as exact as if measured and cut by the aid of a pair of compasses. The second cell is placed on the first, the third on the second, and the whole, when completed, is very much like a set of thimbles put one upon another and enclosed in a case. This is very extraordinary: how long might I try before I could cut a round piece of card to close up the thimble which mamma is now using, and especially in making it so that, being filled with honey and placed horizontally, not a drop should escape! Yet the bee does this in a few seconds, and brings a piece from a distance to accomplish it, just as if it preserved in its head the idea of its size. Nor are the other pieces prepared with less exactness. Well has Reaumur said—"If these bees act mechanically, they are very surprising machines; for they not only cut out certain regular figures, but make them subservient to after use. Whether this be attained by instinctive or intellectual means, the glory is due to that intelligence which made them and us."

F. True, papa; but I hope you are not going to stop yet.

Mr. E. I will proceed, my dear, a little further. Another bee is called the poppy-bee,* because it selects the scarlet petals† of the poppy as tapestry for its cells. At Largo, in Ayrshire, a beautiful sea-bathing village, on the Firth of Clyde, Mr. Rennie found in a foot-path a great number of the cylindrical holes of this insect. The interior was rendered smooth, uniform, and polished, to adapt it to the tapestry with which it was to be hung, and which is the next step in the process. It is remarkable that when she has brought a piece which is too large to fit the place intended, she cuts off what is superfluous and carries away the shreds ; and though we should find it difficult to cut the fresh petal of a poppy with a pair of scissors without wrinkling, the bee knows how to spread what she cuts off as smooth as glass. Having thus hung the little chamber all round with this splendid carpet-tapestry, extending it even beyond the entrance, she fills it with pollen mixed with honey, to the height of about half an inch—lays an egg—and over it folds down the tapestry from above. The upper part is then filled in with earth; and thus the showy part of her work is all within. But, mamma, you should have aided us. Well may we say—

* Osmia papaveris.

† The petals are the divisions of the blossom or coloured portion of a flower.

"Thou cheerful bee! come, freely come,
And travel round my woodbine bower!
Delight me with thy wandering hum,
And rouse me from my musing hour;
Oh! try no more those tedious fields,
Come, taste the sweets my garden yields:
The treasures of each blooming mine,
The bud—the blossom,—all are thine!

And, careless of this noon-tide heat,
I'll follow as thy ramble guides;
To watch thee pause and chafe thy feet,
And sweep them o'er thy downy sides:
Then in a flower's bell nestling lie,
And all thy envied ardour ply!
Then o'er the stem, though fair it grow,
With touch rejecting, glance, and go.

Oh, Nature kind! oh, labourer wise!
That roam'st along the summer's ray,
Glean'st every bliss thy life supplies,
And meet'st prepared thy wintry day!
Go, envied, go!—with crowded gates
The hive thy rich return awaits;
Bear home thy store, in triumph gay,
And shame each idler of the day."

And now, Emma, what was your puzzle?

E. To tell me of some little creature like Sims.

Mr. E. And I have done it. I told you first of a caterpillar which lines its cell with silk—and then of the tapestry-hangers; and these bees are called *the*

upholsterers. Doubtless they were the first in the world.

F. There now, Emma, you try in vain to puzzle papa.

E. I see I have failed; but papa will let me try again.

CHEMISTRY.

F. We have done all you mentioned, papa, and now we should like to have the story you promised us.

Mr. E. As you have performed your engagement, my dears, I shall be very happy to fulfil mine. Come, mamma, let us have your aid also.—In the beginning of the eighteenth century, there lived, in the territories of the Elector of Saxony, a man of great learning and science, who took up his residence in a chemist's house. Just before his death he presented his host with a small packet, the contents of which he declared, if used according to his directions, would change metals into gold. It so happened that immediately after the chemist became very rich; it was rumoured that he actually possessed this power; and on the Elector hearing it, he sent for the chemist, declared that all the gold he could make belonged to his sovereign, promised a noble recompence out of the produce of his labour, and threatened confiscation and death as the consequence of refusal. His reply was, that he had but a small part of what was given him left, but that this should be devoted to the Elector's

service. Accordingly he was confined in a castle, and masses of gold were delivered, from time to time, to persons commissioned to receive them, until at length he stated that all the means he had possessed were used, and entreated that he might be set at liberty. This, however, was not satisfactory to the prince, who insisted that he must be acquainted with the secret, and menaced him with death unless he continued his toils. Terrified by the threat, the chemist asked, as a last resource, a respite of twelve months for further experiments; after which time he agreed, in the event of failure, to submit to the sentence. With some difficulty this was granted; he was confined with a close guard, to prevent escape; and, when the year had elapsed, he was no nearer the discovery of "the philosopher's stone," of which so many had been in pursuit, than he was at first; but though he was unable to turn metals into gold, he obtained, at the close of one of his experiments, a substance almost as precious,—the material from which Dresden china was made,—a result which so much gratified the Elector that he bestowed a large estate on the inventor and raised him to the rank of nobility. Thus pursuing what is imaginary he found what is real; as the absurd and ridiculous efforts of men, called Alchemists, laid the foundation of the interesting and invaluable science of chemistry.

F. What is chemistry, papa?

Mr. E. It relates to the changes which take place in the sensible qualities of bodies, from the action of one kind of matter on another; as the ascension of water from the earth in the form of vapour, from the influence of the sun; or the formation of coal, from the changes which vegetables undergo when their vital properties are lost and they are acted on by other means. Indeed, it teaches the nature of all substances; the relations of those which are simple, to heat and to one another, or their combinations together; the composition of those which nature produces in a compound state; and the application of the whole to the arts and manufactures. Instruction in the science, generally, I must defer till another time; and shall now confine myself to some striking facts in connexion with the Chemistry of Animated Nature. Were I to take you into the elaboratory, or workshop of a chemist, you would see it occupied a considerable space,—that his instruments, utensils, or apparatus were many and various,—and that he required a great number of solids and fluids for the accomplishment of his purposes; yet we find similar results produced by what is contained in the body of a small insect. How amazing then is this! Where shall we begin, mamma?

Mrs. E. Perhaps with, as Milton says—

> "Millions of spinning worms,
> That in their green shops weave the smooth-haired silk."

Mr. E. Very good. In the work-rooms of goldsmiths or gold wire-drawers, there are certain iron plates, pierced with holes of different sizes, through which they draw gold and silver wire, first through the larger and then through the smaller, according as it is required to be fine. Now, the silk-worm has under her mouth just such an instrument, having a pair of holes which are united in one on the outside. This is connected with the part which provides for us the silk, and which is formed of two long floating twisted tubes, growing slender towards the head of the insect, where they unite to form the spinneret which renders the silk. The length of these vessels depends on the quantity of silk wanted by the insect; those of the silk-worm are about ten inches long, while those of the larva of the goat-moth are little more than three inches. The silk-worm fixes the first drop of gum that issues from these vessels through the holes just mentioned where she pleases, and then draws back her head, or lets herself fall, while the gum, continuing to flow, is drawn out and lengthened. Upon being exposed to the air, it immediately becomes dry, and acquires consistence and strength. Nor is she ever deceived in adjusting these openings, or in calculating the proper thickness of the thread, but always makes its strength proportionable to the weight of her body. The thread varies considerably in colour and texture, and sometimes resembles

cotton or wool. In spiders it is much more soft and tender than that of other spinning insects. A remarkable gnat carpets its paths and place of rest with something between silk and varnish, which it spins, not in a *thread*, but in a *broad* riband.

F. Ah! papa, I think I see chemistry here; for the air acting on the wax makes it silk.

Mr. E. Just so; besides, the preparation of the wax is a chemical operation. Another curious substance secreted by insects is *varnish* or *gum*, with which the eggs are besmeared, and placed upon or near the food adapted to the young larvæ or grubs. It is thus that most butterflies and moths attach their eggs to the stems, twigs, and leaves of plants, and that ladybirds and others deposit them in the midst of aphides, or plant-lice. Some eggs are placed side by side, like a close column of soldiers, others are gummed in parallel rows, while the lackey-moths range theirs round the twigs of some trees in numerous circles; and that with such admirable art that they might be taken for pearls set by the skilful hand of a jeweller rather than the eggs of an insect. Reaumur has described the eggs of one covered with down, and arranged in an elegant spiral form, as if mamma were to wind one of the ends of her fur tippet round a branch, making it like a corkscrew. The spiral form of eggs thus deposited may, in particular years, be seen in almost every orchard and

every hedge. If examined, the egg will be found somewhat of the form of a funnel-shaped wine-glass —broader at top than at bottom; and it is worthy of remark, that this is the exact form of the arch-stones of a bridge. They are, in fact, built together in the arched form. This, together with the strong cement used in uniting them, renders it difficult to crush them, though considerable force be used for that purpose; and this even when they are slipped off the branch, round which they were set like pearls on a bracelet, which is the name given them by the French peasantry. The cement, also, is so hard that when pressed it resists the nail, and the heaviest rain dashes on the eggs without injury.—A *gluten* or *jelly* too, is sometimes produced. One mass has been described as about an inch and a quarter long, and rather wider in the middle; it was attached to some aquatic grass, and from one end to the other ran a spiral thread of very small eggs. Of honey and wax I told you in our conversation on "the Confectioners;"—mamma can probably recollect something about odours.

Mrs. E. Many beetles emit an agreeable *scent.* The rose-scented capricorn or musk-beetle has long been noted for its delicious scent of roses, which is so powerful as to fill a whole apartment, and the insect retains it long after its death. Other insects have scents resembling cedar, water-cresses, saffron,

water-lilies, high-scented ripe pears, &c. &c. Some have offensive odours which nature has enabled them to discharge, to terrify their enemies. We have had an opportunity, says Mr. Rennie, of examining the curious organ, supposed to be intended for defence, in the very beautiful caterpillar of the swallow-tailed butterfly. It is of a fine green, banded with black. The instrument in question is of a dark orange, and is always concealed within one of the rings on the shoulders, unless the creature be irritated, when it darts it out about an inch, and, at the same time, emits a strong odour resembling fennel. Papa, do you remember the cannonader?

Mr. E. Yes, my dear. You mean the small green beetle,* not uncommon near London; which gives battle to its enemies by repeated discharges of smoke and noise. This species, however, is not so well known as the bombardier.† When we attempt to catch it, we are surprised by a discharge like that of a pop-gun, accompanied by a sort of smoke, of which it has a bladder sufficient to fire off, according to Rolander, twenty shots in succession. Its chief enemy is a beetle, larger than itself, which hunts it without mercy. As it finds it cannot escape by speed of foot, it stops short, and awaits its pursuer; but just as he is about to seize it, he is saluted with a discharge; and, while he is for a moment stupified with

* Anchomenus prasinus. † Brachinus crepitans.

surprise, the bombardier endeavours to gain a hiding-place.

F. Papa, were I to find one, would he be *sure* to fire?

Mr. E. No, he is not always prepared, or always in the humour, as some have found, though Stephens says it is otherwise, and another gentleman states that one he met with performed the operation no less than thirteen times in rapid succession. What can you suggest, my dear, as to that luminous preparation or secretion, which has all the advantages of our lamps and candles without their inconveniences; which gives light sufficient to direct the motions of insects, while it is incapable of burning; and whose lustre is maintained without needing fresh supplies of oil, or the application of the snuffers?

Mrs. E. An insect called the lucing serves the natives of the Spanish West India Islands *instead of candles;* while many persons, it is said, rub their faces with these creatures when killed to meet their neighbours with a flaming countenance, and derive amusement from their fright. Many other insects have a like power. "In all these cases," as Paley remarks, "we see the resources of art anticipated. One grand operation of chemistry is the making of phosphorus; and it was thought an ingenious device to make phosphorus matches, to supply the place of lighted tapers. Now, this very thing is done in the

body of the glow-worm. The phosphorus is not only made, but kindled; and caused to emit a steady and genial beam." We ought, however, to notice two insects which have become useful to man by their chemical properties; and if papa will tell you of the one from which we have cochineal, I will relate what I recollect of the other.

Mr. E. The cochineal* insect of South America has now, by the superiority of *the crimson dye* it affords, superseded every other. It feeds on a species of fig-tree, called the nopal, and, at the approach of the rainy season, the cultivators sweep from the leaves several little insects which suck the green plant, preserve them in their houses, and feed them with the branches of the nopal. At the close of the rainy season, twelve or fourteen of these insects, by that time grown strong, are put into little baskets, made of moss, or the down that covers the cocoa-nut; and these, being placed on the nopal, the cochineal insects spread themselves over the tree in a few days, and give birth to an immense number of young. These, forsaking the baskets, disperse themselves over all the verdure of the nopal, and some produce a second brood, and afterwards, a third race appears. Many of the parents are killed, some of the young are preserved, and all the rest are destroyed; when their

* Coccus cacti.

insides are found to be filled with a beautiful red dust. Plantations containing fifty or sixty thousand trees, growing in straight lines, may be seen in some districts of America. The quantity of insects annually exported from South America is valued at £500,000. Their trunk is so brittle, that they cannot be moved from their place without breaking it, and hence, during the whole term of their life, they remain fixed to the spot where they first settled, and to the vegetable which feeds them. Another very remarkable circumstance is, that when the young are produced, a multitude of spiders fasten their nets to the leaves of the nopal, and along these slender threads, which serve for a bridge, the brood goes to a neighbouring tree in quest of food.

Mrs. E. The gall-nuts, used in making ink, are produced by an insect which pierces the leaves of a species of oak very common in Asia Minor, where they are collected in considerable quantities by the poorer inhabitants, and from the different ports of the Levant, they are sent to various parts of the world. Those most valued are the blue galls which are the produce of the first gathering, before the fly has issued from the gall. The true vermilion kermes, and a variety of other valuable colours, or drugs, have no other origin than the punctures of different insects. I may also just mention, that, in the body of the cuttle-fish, there is a vessel that contains a quantity

of dark or inky fluid, which the animal emits, on contraction, when alarmed :—

> "The endangered cuttle thus evades his fears,
> And native hoards of fluid safely bears.
> A pitchy ink peculiar glands supply,
> Whose shades the sharpest beam of light defy:
> Pursued, he bids the sable fountain flow,
> And, wrapp'd in clouds, eludes the impending foe."

It might have been added that this fluid not only tinges the water to conceal the retreat of the fish, but is, at the same time, so bitter as immediately to drive off its enemies. Swammerdam thought that Indian ink was nothing more than this black fluid in a certain state, with the addition of perfumes.—I hope, too, we shall be able to tell you something of the effect of *heat* on eggs, before we leave the subject.

Mr. E. I remember Addison says, that "a chemical operation could not be followed with greater art or diligence than is seen in hatching a chicken." The contents of an egg principally consist of nutriment adapted to the different parts of the germ of the living creature it is to contain—the yolk for nourishing the soft parts; the white for the blood and other fluids; and the shell, for the bones. In the case of insects, birds, fishes, and reptiles, the embryo, or germ, is placed in the best position for partaking of the repast, namely, in a particular corner, where it may breathe

fresh air, always communicated to the chamber of the egg by passages in the shell; so that, if these be shut up, by covering the egg with grease, varnish, or chalk, it is suffocated, and dies. It is said that the rudiment of the chick, while still a small point, is lodged on the film that covers the yolk, near the centre of the egg; and, as the floating wick of a mariner's lamp is always kept on a level with the surface by the motion of what suspends it, and the weight of the oil-vessel tending downwards, however the ship moves—there is a natural mechanism which keeps the embryo chick from being upset when the egg is stirred. A membrane is a web of several sorts of fibres, and the yolk is sustained by two membranous ribands, seen at the opening of the egg, and fastening it on each side to the common membrane glued to the shell. These bands, being fixed above the centre of the yolk, the more weighty part, of course, always descends in every position of the egg, as far as they will allow, and the chick being thence kept from sliding down, nourishes itself in security.

E. Is it so, papa, in insects' eggs?

Mr. E. They are too small to allow us to determine if they have any similar contrivance, but the speck has often been seen where the embryo insect was placed just within the shell of the egg. To make it fatten on the good things stored up in his egg-shell chamber, a certain degree of heat is necessary, and this being

applied, it is nourished by them, and thence increases proportionably in size. Light, however always acts unfavourably.

F. That is very singular. But how do they get the heat?

Mr. E. Most birds supply it by sitting on the eggs during a certain number of days; but reptiles, such as crocodiles, bury their eggs in the warm sand on the banks of rivers. Insects seldom, if ever, sit on their eggs. A few instances, however, have been observed of something like it. De Geer found a female ear-wig under some stones, and brooding over a number of eggs, of whose safety she seemed not a little jealous. In order to mark her proceedings, he placed her in a nurse-box filled with fresh earth, and threw the eggs in it at random; but she soon collected them all into one spot, carrying them one by one in her mandibles, and placing herself over them. She never left them for a moment; in about five or six weeks the grubs were hatched, and were then of a whitish colour.

E. Is not that, papa, the disagreeable thing that gets into people's ears, and then into the brain?

Mr. E. It has been *said* to do this; if, however, it ever got into an ear, it would be glad to get out again; and it can no more get to the brain than you can into the passage from this room when the door is fast. But the *stings* of insects must not be overlooked.

The sharpness of the point, the firmness of the substance, the strength of the muscles with which the weapon is darted out, compared with the smallness and weakness of the insect, and the softness of the rest of the body, cannot be too much admired. The sting of a bee will pierce through a goat-skin glove. But, were this all, it would hurt no more than a fine needle; and hence, in its action, we see the union of mechanism and chemistry. The one appears in the piercer, the other in the venom; which must indeed be very powerful, when such a small quantity can produce so great an effect. The venom of the bee, too, is made from honey, the only food of the insect, and the last thing from which we should have thought so strong a poison could have been prepared. The machinery would have been useless without the chemistry, and the chemistry without the machinery; but here we witness an amazing combination of both. And now, mamma, what can we have?

Mrs. E. That most wonderful chemical process—*digestion.*

Mr. E. Wonderful it is, my dear, beyond all description. What an amazing fact is it, that, in one insect, the gullet expands into a crop, which includes a gizzard, wherein the skill of the Almighty is peculiarly manifest; for, though so small as scarcely to exceed in size a large pin's head, it is said to have four hundred pairs of teeth, moved by an infinitely

greater number of muscles—and for what? To grind the timber to powder which this beetle has to pierce and to devour. The gastric juice which is in the stomach of animals has very peculiar properties. It will not attack living matter, but only what is dead; thus, while it eats and dissolves the food, it does not hurt the stomach. It is stronger in operation than aqua fortis, and yet, nevertheless, is as mild, and bland, and inoffensive, to the touch or taste, as gum-water; which it much resembles. It may, well, therefore, be styled the "chemical wonder of animal nature."

F. Is this juice always the same, papa?

Mr. E. No, my dear. It differs in different animals, according to the food on which they live; thus, in birds of prey, as owls, hawks, kites, it only acts on animal matter, and does not dissolve vegetables. In other birds, and in all animals feeding on grass, as oxen, sheep, hares, it dissolves vegetable matter, as grass, but will not touch flesh of any kind. Still further, there is a most curious and beautiful correspondence between this juice in the stomach of different animals and other parts of their bodies, connected with eating and digesting their food. The juice is designed to convert what they eat into a fluid, from which, by various other means, all their parts—blood, bones, muscles, &c., are formed. But the food is first to be obtained, and then prepared, by bruising,

for the action of the juice. Now birds of prey have claws and beaks for tearing and devouring their food, which consists of animals of different kinds, but these instruments are useless for picking up and crushing seeds; accordingly, they have a gastric juice which dissolves the flesh they eat; while birds which have only a beak fit for pecking, drinking, and eating seeds, have a juice that dissolves seeds, but not flesh. Nay, more, the seeds must be bruised before the juice will dissolve them, and hence the birds have a gizzard, and animals which graze have flat teeth, which grind and bruise their food before the juice is to act upon it.

But, Emma, dear, you seem quite absorbed. Like Ellen, the Lady of the Lake, you have sat "with eyes upraised, and lips apart," but you have scarcely uttered a word.

E. Papa, I am full of surprise. Wonder keeps me still; and, like the parrot of whom you told me yesterday, I may say, "I think the more!"

Mr. E. I am glad it is so, my love. I shall rejoice in future years to enlarge your views of this amazing and delightful science. To recur to only one topic of our conversation, let us remember that, whether our gratitude is excited by the freshness of the air, the verdure of the earth, or the lustre of the waters, we are indebted for them all to that boundless benevolence that has granted us the agency of *heat*. Without this, the earth would be an impenetrable rock,

alike incapable of supporting the animals that now graze on its surface, or the plants that spring from it—at once so ornamental and beneficial; the waters would be for ever destitute of fluidity and motion; and the air would lose its elasticity and use. To the operations of art it is equally necessary. By its influence rocks are rent, and the hidden treasures of the earth are obtained. Matter, too, is variously modified; furnishing us with instruments of great value, warm and ornamental clothing, wholesome and delicious food, and needful and effectual shelter. To sum up all, heat is closely connected with the vital power, for, when this is withdrawn, we cease to live.

THE MINERS.

"We have a charming view of the ocean from these windows," said Mrs. Elwood, "and the breeze which now comes this way is most genial, bracing, and delightful. What a busy scene do the sands present! How numerous are the vehicles driving backwards and forwards!—donkeys, poneys, and horses, too, gaily canter and trot to and fro;—promenaders also are increasing;—some pacing cautiously as if still enervated—others walking briskly as if all their health and energy had returned;—here and there a kind mother, or sister, or aunt, is picking up shells and stones for the little buoyant, yet anxious, group around her; while, far out, prying among the weed-covered stones from which the tide is just retiring, a figure may be discerned engaged in the same pursuit, seeking, perhaps, a memorial for some beloved friend, or some shell to enrich his cabinet. Often have I been pleased with a view of the bottom of the ocean round our own shores during a calm; but what must it be in tropical climates!

"The floor is of sand, like the mountain-drift,
And the pearl-shells spangle the flinty snow;
From coral-rocks the sea-plants lift
Their boughs where the tides and billows flow;
The water is calm and still below,
For the winds and waves are absent there,
And the sands are bright as the stars that glow
In the motionless fields of the upper air.

"There with a light and easy motion
The fan-coral sweeps through the clear deep sea,
And the yellow and scarlet tufts of ocean
Are bending like corn in the upland lea;
And life in rare and beautiful forms
Is sporting amid those bowers of stone,
And is safe when the wrathful spirit of storms
Has made the top of the waves his own."

"That is a beautiful description," said Mr. Elwood; "nature in its simplicity, grandeur, and beauty, must always charm; but how extraordinary are some of the works of art!—for instance, a Chinese grotto constructed a few years ago by order of the Sultan of Cheribon. I will read you a most graphic account of it. 'This work, in various grotesque forms, extends over more than an acre and a half of ground, and is so fancifully diversified as to bewilder the senses and defy description. A person wandering among its mazes—where all is art, of the most uncommon character, and utterly unlike any thing in nature—might imagine himself walking, in a dream,

among such scenery and images as never were made visible to eyes of men awake. The entrance is through an old door, with its joints and cornice curiously carved. Thence, onward, is a passage, two yards wide, between columns and statuary of the roughest style, yet evidently wrought by no mean hand. At the termination appears a brick gateway, on each side of which is placed a most outrageously mis-shapen lion of porcelain ware. From this portal we passed into a labyrinth of grottos—mounts, descents, subterraneous ways, interior rooms, unexpectedly opening upon us; and all these decorated with Chinese temples, pagodas, figures of birds, beasts, fishes, and monsters, which no naturalist could classify, absolutely crowding the contracted view on every side. Several pools of water here and there, like inlaid mirrors, reflecting the span-breadth of sky above, and the little circuit of rocks and images around, add much to the enchantment of the whole. Besides these, streams, cascades, and fountains are carried through every part. In one of the recesses we were shown the sultan's bedstead, superbly carved and gilded. This was so placed, that, by a singularly ingenious contrivance, a current of water was conducted all round the tester, which, at pleasure, might be made to fall in transparent curtains of rain, completely encircling the royal couch, for the double purpose of keeping off the musquitoes and tempering

the warm air to the delicious coolness which, in this sultry climate, is the consummation of bliss to reposing listlessness.' "

"It is indeed a most remarkable place, my dear," said Mrs. Elwood; "but what say you to a conversation about other cavern-makers—the little tenants of earth and air—when the children have returned from their ramble?"

"I will make one of the party, most heartily," said her husband.

As soon, therefore, as Frederick and Emma arrived, they took their seats, smiling with pleasure and expectation; and, after a few moments, their father thus proceeded.

"The fox* prepares himself a convenient den, which is so contrived as to afford the best possible security to its inhabitant; being situated under hard ground, the roots of trees, and sometimes in the crevices of rocks; and having outlets, through which he may escape in case of necessity. His care and dexterity in constructing for himself a habitation, is considered by Buffon as alone sufficient to rank the fox among the higher order of quadrupeds. The striped or ground-squirrel,† a native of America, digs burrows in the earth; these are deep, and commonly divided into many branches, from one of which there is an opening to the surface of the ground. The

* Canis vulpes. † Sciurus striatus.

dwellings of these creatures are formed with much art; being worked into long galleries, with branches on each side, and each ending in an enlarged apartment, in which they hoard their stock of winter provisions. Their acorns are lodged in one; in a second, the maize; in a third, the hickery-nuts; and in a fourth, perhaps their most favourite food, the chesnut. In Siberia, it is said, they hoard up the kernels of the stone-pine in such quantities, that ten or fifteen pounds' weight of these have been taken out of a single magazine. The Siberian jerboas,* too, prefer dry, hard, and clayey ground for the place of their habitation. In this they make their burrows very speedily, not only with their fore-feet, but with their teeth; and fling the earth back with their hind-feet, so as to form a heap at the entrance. The burrows are many yards long, and run obliquely and winding; but not above half a yard deep below the surface. They end in a large space or nest, where the purest herbs are laid. They have usually but one entrance; yet, by a wonderful sagacity, the animals work from their nest another passage, to within a very small space from the surface, which, should danger arise, they can burst through, and so escape. And now, my love, I should be glad for you to proceed.

E. I hope, papa, you have not given us all the good tales.

* Dipus jaculus.

Mrs. E. You need not fear, Emma; a large store remains. I will begin with the mole,* every part of which is adapted to its mining condition. Its feet are actually so many shovels to dig out the earth; its cylindrical and compact form requires the least possible quantity to be removed for its progress; it has nearly the same structure of the face and jaws as a hog, and the same use of them; the nose is sharp, slender, and strong, with a pair of nerves going to the end of it; while its covering rejects the adhesion of almost every kind of earth, defends the animal from cold and wet, and from the impediment it would have if the mould stuck to its body. It comes forth, from all sorts of soil, bright and clean; and, though inhabiting dirt, is of all animals the neatest.

E. What kind of house, mamma, does this very nice and tidy little creature make?

Mrs. E. The parent animals, my love, begin by raising the earth and forming a tolerably high arch. They leave partitions, or pillars, at certain distances; beat and press the earth; interweave it with the roots of plants; and render it so hard and solid that no water can get in. They then raise a little hillock under the principal arch, upon which they lay herbs and leaves as a bed for their young. The internal hillock is pierced on all sides with sloping holes, which descend still lower, and serve as passages for

* Talpa Europæa.

the mother to go out in quest of food for herself and her offspring. These by-paths are beaten and firm; they extend about twelve or fifteen paces, and issue from the principal mansion like rays from a centre. Under the superior vault we likewise find remains of the roots of the meadow-saffron, which seems to be the first food given to the young.

F. I should hardly think, mamma, you can find a more curious story than this.

Mrs. E. I really think I can, my dear; but the more the works of God are studied, the more will their wonders appear. The razor-shells,* like many bivalved, or two-shelled fishes, have an extraordinary instrument something like a leg or foot, but called *the tongue.* These creatures are incapable of going forward on the surface, but they dig a hole in the sand, sometimes two feet deep, in which they can ascend or descend at pleasure. The tongue, by which these movements are performed, is fleshy, cylindrical, and situated near the centre of the body. When necessary, the animals can make the end of the tongue assume the form of a ball. The razor-fish, when lying on the surface of the sand, and about to sink into it, extends its tongue from the inferior end of the shell, and makes the extremity of it take the form of a shovel, sharp on each side, and ending in a point. With this it cuts a hole in the sand. After the hole

* Solen siliqua.

is made, it moves the tongue still further into the sand, makes it assume the form of a hook, and with this it obliges the shell to descend into the hole. In this manner the animal acts, until the shell totally disappears. When it chooses to regain the surface, it forms the end of the tongue into the shape of a ball, and makes an effort to extend the whole tongue: but the ball prevents any further descent, and the muscular effort necessarily pushes the shell upward until it reaches the surface. It is amazing with what dexterity and quickness these seemingly awkward movements are performed.

E. There, Fred, you see mamma is right again, as she always is.

F. I do, Emma. I wonder what can come next.

Mr. E. The bank-swallows, or sand-martins,* just occur to me: "I have seen a pair of them," says Mr. White, "make great dispatch; and could remark how much they had scooped out that day, by the fresh sand which ran down the bank, and was of a different colour from that which lay loose and bleached in the sun." These birds work with their bill shut, and may be seen clinging with their sharp claws to the face of a sand-bank, and peg in with their bills as a miner would do with his pickaxe, till they have loosened a considerable portion of the hard sand, and tumbled it down amongst the rubbish below. Some

* Hirundo riparia.

of these holes are nearly as circular as if they had been marked out with a pair of compasses, while others are irregular in form; but this seems to depend more on the sand crumbling away than upon any deficiency of skill. The bird always uses its own body to determine the proportions of the gallery; it perches on the circumference with its claws, and works with its bill from the centre outwards: and hence the latter is always more scooped out than the former. It consequently takes all positions while at work in the inside, hanging from the roof of the gallery with its back downwards as often as standing on the floor; and sometimes it has been seen wheeling round in this manner on the face of a sand-bank, when it was just breaking ground to begin its gallery. To this it is owing that all the galleries are more or less tortuous, or winding, to their termination, which is at the depth of from two to three feet; where a bed of loose hay, and a few of the smaller breast-feathers of geese, ducks, or fowls, is spread with little art for the reception of the eggs.—But Frederick and Emma will be gratified, mamma, if you will favour them with an account of an American owl, which, by the way, unlike its namesakes here, is a day-bird.

Mrs. E. In some parts of the United States, the burrowing-owl* resides exclusively in the villages of the marmot or prairie-dog, whose excavations, or caverns,

* Strix cunicularia.

are so commodious as to render it unnecessary for the bird to dig for itself, as it is said to do where no burrowing animals exist. These villages are very numerous, and variable in their extent, sometimes covering only a few acres, and at others spreading over the surface of the country for miles together. They have the form of a truncated cone, or sugar-loaf cut short, about two feet wide at bottom, and seldom rising as high as eighteen inches above the surface of the soil. The entrance is either at the top or in the side, and the whole is beaten down externally, and resembles a much-used foot-path.

F. How does it look inside, mamma?

Mrs. E. The passage descends either vertically, or side-ways for one or two feet, and is thence continued until it ends in an apartment, where the industrious marmot constructs, at the approach of the cold season, a comfortable cell for its winter's sleep. This cell, which is formed of fine dry grass, is globular in form, with an opening at top which will admit a finger; and the whole so firmly compacted, that it might, without injury, be rolled over the floor. These burrows are always kept in the neatest repair, and are often inhabited by several individuals. When alarmed, they instantly take refuge in these chambers; or, if the danger be not immediate, they stand near the brink of the entrance, bravely barking and flourishing their tails, or else sit erect to observe the movements of the enemy.

E. And so, mamma, you say that the owls live in these curious places.

Mrs. E. In all of these prairie-dog villages this bird is seen moving briskly about, or else in small flocks, scattered about, and at a distance may be mistaken for the marmot itself when sitting erect. Though not timid, they will soar to a distance if disturbed, or descend into their dwellings, whence they are difficult to dislodge. And now I think we may pause, papa.

Mr. E. In a few moments we will; but we have as yet said nothing about insects. I must first read you a passage from the work which contained the account of the cavern,* which I am sure you will consider very appropriate:—"There is an insect in the mountains here (Pinang), a species of gryllus (cricket), which makes a loud noise with its wings, at certain seasons, probably to attract its mate. Not content with the simple sound which it can produce by a natural action, it is said to resort to an exceedingly curious contrivance to increase it; but we shall merely describe its nest, leaving its musical capabilities to better judges. In the sides of a hole which it forms in the earth, large enough to contain its body, it hollows out seven small tunnels, which, diverging from that common centre, and penetrating towards the surface of the ground, at length open in a circle of

* Montgomery's Voyages of Tyerman and Bennet.

a palm's breadth in diameter. These cylindrical apertures, being made quite smooth within, expand towards the top, where each may be half an inch wide, like so many minute speaking-trumpets. The insect then taking its stand in the central cavity which communicates with these, and there exercising its fairy minstrelsy, the sound passes through every tube; and, whatever be the use of this peculiar structure, the tiny musician within makes hill-side and thicket to ring with the chirruping din that he emits from it."

Mrs. E. That reminds me of the mole-cricket,* which I am surprised I could forget. It burrows in the ground, and forms extensive galleries, similar to those of its name-sake, though smaller, and which it digs along, in the manner of the field-mouse. The structure of its arms and hands, if so they may be called, is well adapted for these operations, being both very strong, and moved by a peculiar apparatus of muscles. The breast is formed of a thick, hard, horny substance, which is further strengthened within by a double frame-work of strong gristle, in front of the extremities, of which the shoulder-blades of the arms are firmly jointed; a structure evidently intended to prevent the breast from being injured by the powerful action of the muscles of the arms in digging. The arms themselves are strong and broad, and the hand is furnished with five long sharp claws, pointing

* Gryllotalpa vulgaris.

somewhat obliquely outwards, this being the direction in which it digs, throwing the earth on each side of its course. Mr. White, of Selbourne, says, that a gardener, at a house where he was on a visit, while mowing grass by the side of a canal, chanced to strike his scythe too deep, and pared off a large piece of turf, laying open to view an interesting scene of domestic economy. There was a pretty chamber dug in the clay, in form and size as if it had been moulded by an egg, the walls being neatly smoothed and polished. In this were laid about a hundred eggs, of the size and form of carraway comfits, and of a dull tarnished white colour. The eggs were not very deep, but just under a little heap of fresh mould, and within the influence of the sun's heat.

Mr. E. What would you say, Emma, to a mining-spider, and a very clever one too?

E. Dear, papa, I should never have thought of a spider being a miner! I thought he only made cob-webs to catch flies. But he certainly must be *very* clever if he is a miner at all.

Mr. E. A spider found in the West Indies,* digs a hole in the earth downwards and aslant, about one inch round and three inches long. This cavity she lines with a tough thick web, which, when taken out, resembles a leathern purse; but, what is most curious, this house has a door with hinges, and herself and

* Migale nidulans.

family, who tenant the nest, open and shut the door whenever they pass or repass. A nest has lately been seen in this country, which is composed of very hard clay, deeply tinged with brown. It is in form of a tube, about an inch in diameter, between six and seven inches long, and slightly bent towards the lower part. The tube is lined with an uniform tapestry of silken web, of an orange-white colour, in texture something between Indian paper and very fine glove-leather. A circular door, about the size of a crown piece, is formed of more than a dozen layers of the same web, which lines the inside, closely laid upon one another, and shaped so that the inner layers are the broadest, the outer being gradually less, except towards the hinge, which is almost an inch long; and as all the layers are united there it becomes the strongest and thickest part of the work. As the materials are elastic, the hinge acts like a spring, and shuts the door of the nest by itself. It is, besides, so accurately made, that it is almost impossible to find the join, and the door has been opened and shut hundreds of times, without in the least injuring the power of the spring. When the door is shut, it is like the upper valve or shell of a young oyster; and the whole nest is of a blackish-brown colour.

E. I think, papa, though you have told us of many very clever little creatures, no one is more ingenious than this. Who would have thought of a spider

making a door, and a hinge, too, and the hinge to go like a spring!

Mr. E. This, my dear, has been called, and I think very properly, the perfection of insect ingenuity. The most remarkable specimen of human effort in mining of modern times is certainly what has been accomplished to form a tunnel—that is an arched and walled road for passengers and carriages—under the bed of the river Thames. This has been made, it is said, half way across; but the work is stopped for want of funds. In the construction of this singular channel, or bridge, *under* water, projected and carried forward by Mr. Brunel, an apparatus was used called "a shield;" and he has lately stated, at a sitting of the Royal Academy of Sciences at Rouen, that the idea of this suggested itself to him on examining the formation of a little animal named Taret, which under water is capable of perforating large pieces of timber. Upon its head is a species of shield, which enables it to resist the action of the waves, in the midst of which the creature pursues its occupations undisturbed. Here, then, is a striking instance in which art imitated nature.—Let us now engage in other pursuits.

THE SOLDIERS.

THE family were in London, and Emma and Frederick greatly enjoyed its sights. They visited the Zoological Gardens; admired its beautiful walks, gazed with wonder and delight at its fine display of animals and birds, and laughed heartily at the gambols of the bears which ran up the pole, and eagerly devoured the cakes and buns offered to them by the visitors. They went also to the Tower, and saw the armoury, where swords, guns, and pistols, were ranged like suns, moons, and stars; and the representations of the kings in martial attire, and the figure of Queen Elizabeth with her petticoat of steel covering one of white satin, and the splendid crowns and regalia used at the coronation of our gracious king and queen—all so bright, and splendid, and dazzling. And then there were exhibitions of paintings and water-colour drawings—historical pictures, and landscapes, and portraits, and miniatures—and they thought they should have liked them all, but especially a picture of blindman's buff, which they were quite sure was very natural indeed.

One fine morning, Mr. Elwood took them to the park, when the soldiers were assembled in front of the Horse Guards; and they were amused by their various evolutions, charmed with the gay and spirited music, and looked with great eagerness, when the colours were brought out, and all marched round, and round, and round, with the splendid regimentals glittering in the sun-beams, and the banners waving in the gentle wind.

No sooner had they returned, after many inquiries about privates, corporals, serjeants, ensigns, colonels, and generals, than Frederick related to his mamma what they had witnessed, while Emma's bright eyes told how much she was pleased, and her ready mind assisted her brother in many of the details which he had forgotten. Anxious to impart interesting and useful instruction to his beloved children, and aware that what is connected in the memory with any thing which has deeply interested, is very likely to be retained, Mr. Elwood felt that there was now a favourable opportunity for mentioning the conflicts which take place among *irrational* creatures; to which, however, men in their wars may too often be compared. Having stated his intention he thus proceeded:—

Mr. E. There is a most beautiful little creature, called the humming-bird; the male is of a green gold colour on the upper part, with a changeable copper gloss, and the under parts are grey; while the throat

and part of the neck are of a ruby colour, in some lights as bright as fire.

E. Oh, what a *dear* little thing!

Mr. E. I remember seeing on a case of humming-birds in Bullock's museum, the following very appropriate inscription:—

> Who can paint
> Like nature? Can imagination boast
> Amid its gay creation, hues like these?

It is singular that it never feeds but on the wing, suspended over the flower, whose nourishment it extracts through the tubes of its curious tongue. It seems, however, beautiful as it is, very ill-tempered; for, should it find that any of its brethren have robbed a flower of its honey, it is plucked off in a rage, thrown on the ground, and sometimes torn to pieces. Indeed, these little creatures are given to the most violent passions, and they have often dreadful contests when many happen to wish for the same flower. During the fight they frequently pursue the conquered into the apartments of those houses whose windows are left open, pass round the room as flies do here, and then suddenly regain the air. They appear quite fearless of mankind; and, should they observe any one climbing the tree in which they have nests, they attack him violently in the face, and come, go, and return, with such swiftness, as is almost incredible. Now, mamma, tell us of another battle.

Mrs. E. Rooks are exceedingly fond of any spot they select. Of this I can give you a singular instance. A pair of them, after trying in vain to settle in a rookery at no great distance from the exchange at Newcastle, were obliged to abandon the attempt, and take refuge on the spire of that building; and, although constantly interrupted by others, they built their nests on the top of the vane, and reared their young, regardless of being turned about by every change of wind, and of the noise of the populace below. Nor was this all; they returned and built their nest there annually, for ten years, soon after which the spire was taken down. Ah! they seemed to know the proverb, "home is home." Another remarkable circumstance occurred, a few years ago, at Dallam Tower, in Westmoreland. Adjoining the park were two groves; in one was a very large rookery, and in the other a number of herons had regularly built and bred for many years. For a long time the two tribes lived in peace; but at length, the trees of the heronry were cut down, and the young brood perished. The parents, not willing to leave the grove, wished to make a settlement in the rookery; but this the rooks determinately opposed: a desperate contest was, therefore, the result, in which many of the rooks and herons lost their lives; at length the latter succeeded in gaining possession of some of the trees, and that very spring built their nests

afresh. Next season a similar conflict took place, which, like the former, ended in the victory of the herons. Since then, peace seems to have been agreed upon between them; the rooks have left part of the grove to the herons, and the two communities appear as harmonious as before the dispute.

F. I have heard you say, papa, "All's well that ends well;" but I think it would be better if these creatures would do without quarrelling; it's very unpleasant, and must make them very unhappy, as it would Emma and me; but *we* never quarrel. Do fishes ever have such disputes?

Mr. E. Yes, often. I will mention one instance. The size and bulk of whales are generally enormous; and their muscular powers so great, that a blow of the tail is at any time sufficient to upset a tolerably large boat; and, when struck upon the surface of the ocean, to make the water fly in all directions with tremendous noise. The whale, however, has a dreadful enemy in the sword-fish. Whenever this appears, it tries all in its power to escape the attack, which, if they meet, is always unavoidable. The sword-fish is sufficiently active to avoid a blow from the tail of his antagonist, the noise of which is said to be louder than that of a cannon; but a considerable space of the sea may be seen dyed with the blood that issues from the wounds of the whale, made by the dreadful beak of his adversary. In calm weather, the

fishermen frequently lie on their oars, watching the combat, till they perceive the whale at his last gasp, when they row towards it; and, as the sword-fish retires at their approach, they share the fruits of his victory. But we have so much to tell you of insects, that we cannot spare time for the battles of any other creatures.

E. What, papa, do insects fight?

Mr. E. The most interesting and beautiful of all the British butterflies is the purple emperor. He appears in the winged state in July, and he always fixes his throne on the summit of a lofty oak, from the utmost sprigs of which he makes his aerial excursions in sunny days. In these he ascends to a great height, sometimes rising beyond the reach of the eye, especially if he happens to quarrel with another emperor, the monarch of a neighbouring tree. These insects never meet without a battle, flying upwards all the while, and combating furiously with each other; after which they often return to the very sprigs from which they ascended. Queen bees, too, are bitter enemies. Whenever Huber placed a stranger queen in a hive which had a sovereign, a mortal combat always ensued. The spaces between the segments or joints of the belly, are the parts which may be wounded; the rest of the body has armour which resists the sting. As soon as they come in view of each other, they rush eagerly to the fight, endeavour

to gain every advantage over each other, dart out the sting furiously, which may be seen to glance off the corslet of scales; and at last the strongest or the most fortunate contrives to mount upon her enemy, or fix her by the wing against a comb, and curving her body under the belly of her antagonist, inflicts a wound which generally proves immediately mortal. In these combats, the position of both is sometimes such, that each can pierce its foe; but when this is the case, both become panic-struck—instantly separate—and retreat. Huber regards this as a special instinct, since, were both killed, the colony would be ruined. Nor are contests confined to sovereigns, subjects engage in them also; among bees there are always duels, not more than two being concerned in them; and this even when armies of bees meet in combat. What think you of attacks for the sake of plunder? Mamma will, perhaps, describe them.

E. Oh, dear, that is strange, very, *very*, strange!

Mrs. E. It is said that small parties of three or four will unite to rob, as we may say, on the highway. These way-lay straggling individuals, or a humble-bee as it returns to its hive laden with honey. The robbers then make their attack; one seizes by a leg, another by a wing, or perhaps there are two on each side, confining or pulling the limbs, while they use him very roughly, or bite his head. This violence compels him to unfold his tongue and resign his honey, which

they eagerly lap till they are satisfied, and then let their prisoner go. Wasps, too, are audacious robbers of bee-hives; but bees of one hive sometimes make attacks on the hives of others, and have been called by Schirach "corsair-bees." When a hive means to begin robbing, it is said they send spies to observe the state of the neighbouring stocks. A few of these watch about the doors for several days, trying to get in to increase their knowledge, but are driven away by the powerful stocks, who plant guards at their door; and as the weak stocks do not, they are the first to be assaulted. The next day they return in force, and begin a violent siege; when a desperate conflict ensues, both within and without the hive, neither party giving quarter. The stoutest warriors make a desperate attempt, rush forward, and seize the queen; knowing that, by dispatching her, victory is immediately secured, for the assaulted bees always desist and join the victors, the moment they are aware the queen is dead, become as one fraternity, and assist to carry their own treasure to the new habitation. But, should the queen be protected, they fight on with great rage, and death and plunder soon destroy the stock.

Mr. E. The termites, or white ants, are a most singular race; and to a part of their community the duties of war are assigned. On making a breach in one of their castles, a general alarm is raised among

all ranks; but the *labourers,* who were before most commonly seen, being unable to fight, go immediately to the interior, and those called *soldiers* take their places. Immediately on striking the wall, a soldier, probably a sentinel, starts out, walks rapidly over the breach to examine the nature of the danger, and then retires to give the alarm. On this two or three more hurry out, and the news spreading, the breach is soon filled with soldiers, rushing forth to defend their citadel, which they do with great fury. It seems they can only direct their movements by feeling; they bite fiercely at every thing within their reach, and in their haste, frequently lose their footing, and tumble down hill. In biting they often strike upon the wall, and make a noise somewhat shriller and quicker than the ticking of a watch, and this, which may be heard at the distance of several feet, the labourers within seem to understand, as they reply to it with a kind of hissing.

F. I think I should not like to rouse them, papa.

Mr. E. It requires some courage. A gentleman says, he attempted one day to knock off the top of one of the ant-hills with his cane, when the stroke brought out thousands to the door to see what was the matter; on which he ran away as fast as he could. Others have more courage to renew the attack, which greatly increases the bustle and fury. If, in their rage, they come in contact with the hands or legs of their assailant, they make their jaws meet through the skin at

every stroke, and inflict considerable pain, while the blood from one of their wounds will stain the stocking to more than an inch in width. They never quit their hold, but will suffer themselves to be pulled limb from limb, without making any attempt to escape.

E. What happens, papa, if the knocking soon stops?

Mr. E. They retire into the nest as if they supposed the assailant beyond their reach. Then the labourers are seen hastening to repair the breach, every one bearing some ready-tempered mortar in its mouth. This they stick on with amazing quickness, and still more amazing order; for, though millions seem employed, they never embarrass one another. The soldiers now retire in their turn, except one saunters about here and there, never touching the mortar. One in particular places itself close to the part that is repairing; it turns leisurely from side to side, and after every minute or two lifts up its head, and makes a noise with its forceps, on which the labourers give a hiss and redouble their pace.

F. But, papa, how do they make war?

Mr. E. Mamma will answer the question.

Mrs. E. Imagine two of their cities, equal in size and population, and placed about a hundred paces from each other. The whole space which parts them, for the breadth of two feet, appears alive with immense crowds of their inhabitants. The armies meet and join battle midway between their habitations.

Thousands of champions, mounted on higher spots, engage in single combat, and seize each other with their powerful jaws; and a still greater number are engaged on both sides taking prisoners. Multitudes of ants lie dead where the battle rages most, covered with venom; and many, forming groups and chains, are hooked together by their legs or jaws, and drag each other alternately in opposite directions. At the approach of night each party gradually retreats to its own city; but, before the following dawn, the combat is renewed with greater fury, and occupies a greater extent of ground. These daily fights continue till violent rains separating the combatants, they forget their quarrel, and peace is restored.

F. How strange it is that such combats should ever take place!

Mrs. E. I never think of them without feeling that there were no strifes in Eden in the days of innocence; and there would have been none had that state continued. Milton, after describing Eve as lamenting the transgression, finely says:—

> "——— Nature first gave signs, impressed
> On bird, beast, air: air suddenly eclipsed,
> After short blush of morn; nigh in her sight
> The bird of Jove stooped from his aery tour,
> Two birds of gayest plume before him drove;
> Down from a hill the beast that reigns in woods,
> First hunter then, pursued a gentle brace,
> Goodliest of all the forest, hart and hind."

But passing strange is it that men, the noblest of creatures, should delight in war. How affecting are the details of history! What ravages have been made among intelligent, accountable, and immortal beings! Soldiers have been, to a fearful extent, the tools of despots. To mention only one instance, the people of Saragosa passed through fiery trials from the tyranny of Buonaparte. After a series of conflicts, never surpassed in energy and ardour, either by invaders or the invaded, among whom, in this city, women were eminently conspicuous, a most obstinate and murderous contest was continued for several successive days and nights. Under cover of the darkness, the combatants frequently dashed across the street to attack each others' batteries; and the battles which began there were often carried on into the houses beyond, where they fought from floor to floor, and from room to room. The hostile batteries were so near each other, that a Spaniard, in one place, made way, under cover of the dead bodies, which completely filled the space between them, and fastened a rope to one of the French cannons; in the struggle which ensued the rope broke, and the Saragosans lost their prize at the very moment when they thought themselves sure of it. At length, however, they achieved a memorable triumph. But war is, indeed, a dreadful curse. Soon may swords be beaten into ploughshares, and the peace of mankind be for ever undisturbed!

Mr. E. Most heartily do I concur in your benevolent wishes, my dear. Another remarkable fact in the history of the ants, is the expeditions of one species* to capture slaves.

E. Slaves, papa, is it possible?

Mr. E. I will give you the proof. As Huber was walking in the environs of Geneva, he observed at his feet a column of legionary ants traversing the road, moving with considerable speed, and occupying a space of from eight to ten inches long by three or four in breadth. Leaving the road in a few minutes, they passed a thick hedge, and entered a meadow, where he followed them, and observed them winding along the grass in unbroken column, in spite of all obstacles. They soon approached a nest inhabited by negro-ants,† some of which guarded the entrance; but, seeing the approaching army, they darted forth upon it; and, the alarm soon spreading, their companions rushed forth in multitudes to defend their homes. The assailants, the bulk of whose army lay only two paces distant, quickened their march; and, when they arrived at the hill, the whole battalion fell furiously on the negroes, who, after an obstinate but brief struggle, fled to their galleries below the ground. The former now ascended the dome, collected in crowds on the summit, and, taking possession of the principal openings, left some of their companions to

* Formica rufescens. † Formica fusca.

make others in the outer walls. This was soon done, and the remainder of the army entered through the breach, but came forth again in about three or four minutes, each carrying off a pupa, or a grub, with which they returned home in a straggling and irregular march.

F. Could Huber tell what those did who had been robbed of their young?

Mr. E. He soon lost sight of the invaders in a field of ripened corn; and, on returning to the city, he found a few of the negro-workers perched on the stalks of plants, holding in their mouths the few grubs they had been able to rescue from the plunderers. Next morning, however, he witnessed a numerous encampment of the assailants, when the assault was repeated and more grubs captured; and an attack made on another colony with the same success. He got to their encampment just before they reached it, and, to his surprise, observed, all around, a great number of the negroes. He raised up a part of the building; and, upon still seeing more, thought it was an encampment which had been already pillaged; but he was set right by the arrival of the very army he had been watching, laden with their spoils. At this the negro-ants were not alarmed, but even approached the warriors to caress them, and offer them food, while they, in turn, consigned to them their prisoners, to be carried into the interior of the

nest. "I was witness," says Huber, "every day, during summer, to these invasions."

E. Why do they take the poor negro-ants?

Mrs. E. Perhaps, because they are so pacific and docile. The mining-ant is, however, sometimes assailed. It should be observed, that they never capture the old negroes, or miners, as if aware that they could not be tamed down to the condition of slaves. Their only object is to obtain a number of pupæ; and, the city of the stranger becoming their home, they employ their natural activity in storing, repairing, and enlarging it—in fact, making the same exertions as they would had they never been captured. While they are thus engaged in many and laborious employments, their masters rest calmly at the bottom of their city, till the time fixed for their expedition arrives, when they put forth their skill in obtaining hundreds of pupæ, which they confide to the charge of their slaves.

E. But why, papa, do they make slaves?

Mr. E. It appears that the masters could not live without their aid. Huber shut up thirty in a glazed box, supplying them with larvæ and pupæ of their own kind, and with several negro pupæ; excluding all their slaves, and placing some honey in a corner of their prison. Strange as it may seem, they did not attempt to feed themselves; and though, at first, they paid some attention to their larvæ, they soon laid them

down again; most of them died of hunger in less than two days, and the rest appeared extremely weak. At length, he admitted a single negro, which, wonderful to relate, made a cell in the earth, colleeted the larvæ, and plaeed them in it; assisted the pupæ ready to emerge; and preserved the lives of the others that still survived. Useful as the slaves are, they suffer no unkindness; their masters even look up to them, and are sometimes under their control. Thus their state is very different to that of those of whom I have sometimes told you. Speedily may that time come, whe no one on the face of the earth,

"Shall buy, or sell, or hold, or be a slave!"

THE TAILORS.

"LET him go into the kitchen," said Mr. Elwood; "give him some food; and see if you can find some old garments which will shelter him from the bitter blast."

The case was this:—The family had just sat down to breakfast, surrounded by all the comforts of life, when a boy, in the rags of a sailor, and with a countenance indicative of deep necessity, came to the window; and, baring his head to the wind, which was driving the falling snow hither and thither, made a powerful, and, as it appears, effective appeal for sympathy and relief.

"Just as that poor little mendicant came," said Mrs. Elwood, the words of Cowper occurred to my mind:—

"'Fast falls the fleecy shower; the downy flakes
Descending, and with never-ceasing lapse,
Softly alighting upon all below,
Assimilate all objects. Earth receives
Gladly the thickening mantle, and the green
And tender blade, that feared the chilling blast,
Escapes unhurt beneath so warm a veil.'"

Winter has, indeed, its beauties and its charms; but they can only be seen and felt in such circumstances

as ours, where no sense of necessity absorbs the thoughts and feelings, and where we partake its delights without suffering its ills. What a contrast is there, my dears, between our warm and comfortable dwelling, and the houseless state of that wanderer—a table like this, and his precarious and wretched fare—and clothing with which we are so amply provided, and the few miserable garments which hang about his chilled and shivering limbs! How should our gratitude rise and glow towards Him, who has 'given us all things richly to enjoy!'"

"I hope it will, mamma," said Emma; and Frederick joined in expressing the same feeling.

"Your allusion to the garments with which we are so well furnished," said Mr. Elwood, addressing his lady, "suggests a topic on which we may converse, as the state of the weather forbids our going out. Shall we begin," he continued, appealing to his children, "with insects or birds?"

E. With birds, papa. Oh, they are so pretty!

F. I was going to say, insects.

Mr. E. You were at liberty to express your preference; but, our sex, Frederick, concedes what propriety allows to the other; so we begin with birds.

E. It does not matter, papa; let Frederick have *his* way.

Mr. E. I am glad, my dear, you are disposed to do what is most agreeable to others; and Frederick,

I am sure, feels the same; so, first, because you are a young lady; and, secondly, because you act so properly, I shall ask you to read us Wilson's account of orchard-starlings.*

E. (Reads.) "These birds are so particularly fond of frequenting orchards, that scarcely one orchard, in summer, is without them. They usually suspend their nest from the twigs of the apple-tree; and often from the extremities of the outward branches. It is formed, outwardly, of a particular species of long, tough, and flexible grass, knit, or sewed through and through, in a thousand directions, as if actually done with a needle. An old lady of my acquaintance, to whom I was, one day, showing this curious work, after admiring its texture for some time, asked me, in a tone between joke and earnest, whether I did not think it possible to learn these birds to darn stockings? This nest is hemispherical, three inches deep by four in breadth; the concavity scarcely two inches deep by two in diameter. I had the curiosity to detach one of the fibres, or stalks of dried grass, from the nest, and found it to measure thirteen inches in length; and, in that distance, was thirty-four times hooked through and returned, winding round and round the nest! The inside is usually composed of wool, or the light downy appendages attached to the seeds of the plantanus occidentalis, or butten-wood,

* Icterus mutatus.

which form a very soft and commodious bed. Here and there the outward work is extended to an adjoining twig, round which it is strongly twisted, to give more stability to the whole, and prevent it from being overset by the wind.

" When they choose the long pending branches of the weeping-willow to build in, as they frequently do, the nest, though formed of the same materials, is made much deeper, and of slighter texture. The circumference is marked out by a number of these pensile twigs, that descend on each side like ribs, supporting the whole ; their thick foliage, at the same time, completely concealing the nest from view. The depth, in this case, is increased to four or five inches ; and the whole is made much slighter. These long pendent branches, being sometimes twelve, and even fifteen feet in length, have a large sweep in the wind, and render the first of these precautions necessary, to prevent the eggs, or young, from being thrown out ; and the close shelter afforded by the remarkable thickness of the foliage is, no doubt, the cause of the latter. Two of these nests, such as I have here described, are now lying before me, and exhibit, not only art in the construction, but judgment, in adapting their fabrication to their particular situations. If the actions of birds proceeded, as some would have us believe, from the mere impulse of that thing called instinct, individuals of the same species would uniformly build their nests

in the same manner, wherever they might happen to fix it; but it is evident, from these just mentioned, and a thousand such circumstances, that they reason from cause to consequences, providently managing with a constant eye to future necessity and convenience."

F. Then, papa, these orchard-starlings are little tailors; are any other birds like them?

Mr. E. Yes, there is a starling * in some of the West India Islands, which shapes fibres and leaves into the fourth part of a globe, and sews the whole, with great skill, to the under part of a banana leaf, so that this makes one side of the nest. The most skilful, however, is one of varied and elegant plumage, which, from its ingenuity in forming its abode, is called the tailor-bird.† It first selects a plant with large leaves, then gathers cotton from the shrub, spins it to a thread by means of its long bill and slender feet, and then, as with a needle, sews the leaves neatly together to conceal its nest. "The tailor-bird," says Mr. Forbes, "resembles some of the humming-birds at the Brazils, in shape and colour; the hen is clothed in brown, but the plumage of the cock displays the varied tints of azure, purple, green, and gold, so common in those American beauties. Often have I watched the progress of an industrious pair of tailor-birds in my garden, from their first choice of a plant,

* Icterus bonana. † Sylvia sutoria.

until the completion of the nest and the enlargement of the young. How applicable to them are the following lines :—

> Behold a bird's nest!
> Mark it well, within, without!
> No tool had he that wrought; no knife to cut,
> No nail to fix, no bodkin to insert,
> No glue to join; his little beak was all;
> And yet how neatly finished! What nice hand,
> With every implement and means of art,
> Could compass such another?

I might also have stated that after the operation of sewing is finished, the cavity is lined with feathers and soft vegetable down. The nest and birds are together so very light, that the leaves of the most slender twigs which are furthest from the trunk are chosen for the purpose; and thus situated, the brood is completely secured from every invader." Now, Frederick, for the insects.

F. Not just yet, papa, if you can tell us of some more tailor-birds.

Mr. E. I do not remember any others. Perhaps mamma does, or will tell us something instead.

Mrs. E. As nothing more about birds is suggested, I will mention the leaf-cutting bee.* The portions of leaf used for the nest are not glued, nor fastened,

* Megachile centuncularis.

except by nicely fitting together, and yet the liquid honey does not drain through. Now, the mode of obtaining these, demands particular notice. As soon as a rose-bush is chosen, the bee flies round, or hovers over it for some seconds, as if looking for the leaves best suited to her purpose. Having chosen one, she alights upon it, sometimes on the upper and sometimes on the under surface, or not unfrequently on its edge, so that the margin passes between her legs. Her first attack, which is generally made the moment she alights, is usually near the footstalk, with her head turned towards the point. As soon as she begins to cut she is quite intent on her labour; nor does she cease till her work is completed: this is done with her strong jaws as expeditiously as you, or I, Emma, could work with a pair of scissors. As she proceeds, she holds the edge of the separated part between her legs in such a manner, that the part keeps giving way to her, and does not interrupt her progress. She works in a curve line, approaching the mid-rib of the leaf at first, but when she has reached a certain point, she recedes from this towards the edge, still cutting in a curve. When she has nearly separated the part from the leaf, so that it hangs by the last fibre, she balances her little wings for flight, lest its weight should carry her to the ground; and the very moment it is cut off, she bears it away in triumph in a bent position between her legs, and

perpendicularly to her body. Even the tailor carefully measures and marks out his cloth, and the carpenter uses his square and his line; but this little creature, without rule or compasses, metes out what it wants into ovals, or circles, and accommodates the sizes of the several pieces of each figure to each other. So far are human reason and art excelled by the teaching of the Almighty. But, my dear, the rose-bush reminds us of some little creatures which feed on its leaves, as well as on those of other trees, on the under side of which they may often be found in summer.

Mr. E. You refer, my love, to the tineæ, which eat away a part of the leaf, and form an oblong cavity in the interior, and then join the parts with silk so artfully, that the seams are scarcely discernible, even with a glass, and thus form a case, or hive, cylindrical, or roller-like, in the middle, with one opening circular and the other triangular.

E. Have any been seen, lately, papa?

Mr. E. Mr. Kirby saw some a short time ago upon the elders in the Hull botanic garden; and he says that, more ingenious than their brethren, and willing to save the labour of sewing up two seams in their dwelling, they place themselves near the edge of a leaf instead of in its middle. The tineæ, which work in the middle, wholly separate the two surfaces which compose it before they proceed to join them together; but, were

these who work at the edge to do so, the builder and his dwelling would certainly fall; and therefore, before they begin to cut, they *run* up, as your mother would call it, the two membranes on that side. Then, putting out their heads, they cut the intermediate portions, carefully avoiding the larger nerves of the leaf; afterwards they sew up the separated sides more closely, and only intersect, or cut the fibres when their labour is completed. Mamma, do you recollect the cloak-makers?

Mrs. E. Quite well, my dear. Some larvæ, which form their covering of pure silk, are not content with a single coating, but actually cover themselves in another, open on one side, and very much resembling a cloak. It is singular, too, that the silk of it, instead of being all woven alike, is formed into many transparent scales, over-wrapping each other, and altogether very much like the scales of a fish. These mantle-covered cases are inhabited by the larva of a little moth.

E. How do they make a mantle, mamma?

Mrs. E. The field, or rustic-moth, satisfies the cravings of hunger from the green leaf, and prepares the stuff from the two membranes, of which to form it; each of which is to it what a piece of cloth is to a tailor, and, like him, it cuts each piece of the form and proportion it ought to have, to answer the desired purpose.

E. And then how does it go on?

Mrs. E. Reaumur watched it particularly, and removed one while the insect was engaged. It seemed much alarmed on discovering its loss, and came out tail foremost; it felt about for its mantle, but not finding it, it re-entered between the membranes of the leaf, where it began to feed, and having consumed what filled the necessary space, proceeded to repair its loss. From the membranes of the leaf it cut two pieces, equal in extent and similar in shape, each piece being intended to form one half of the mantle; and this was done with singular rapidity and matchless skill. One end of each piece was double the size of the other. The insect then placed itself between the two pieces, while they were flat; it afterwards brought them together at certain points, with considerable spaces still open, while it twisted and turned about its body in all directions, thus moulding them into a concave form suited to its body. Having thus found that the mantle would fit in every part, it brought the edges of the pieces close together throughout their whole length, and sewed them so neatly and firmly, that it was very difficult, even with a glass, to find the seam. The whole was lined with silk, and was completed under Reaumur's inspection in twelve hours. To detach it from the leaf, the insect crawls partially out of its case, pushes its head forward, fastens its fore-legs upon the leaf, and, laying hold of the inside of the

case with its hind legs, separates it instantly from its original place.

F. That is certainly very ingenious. Are other things used besides silk?

Mrs. E. Yes; pieces of lichen, grains of stone, the spines of some species of mimosa, or sensitive plant, ranged side by side, so as to form a very elegant fluted cylinder, pieces of small twigs, stems and leaves of grass, and fragments of grass, bark, &c., formed into cases or sacks. But I must not forget the abodes of clothes-moths,* which, as Kirby says, not only cover themselves with a coat, but with one formed, as papa's and Frederick's are, of wool or hair, most curiously made. The larva makes the stuff of wool or hair artfully cut from our clothes or furniture, with silk drawn from its own mouth, and as this would not be soft enough for its tender and *naked* skin, it lines the inside of its coat with pure silk.

F. Ah! but mamma, I out-grow my clothes; how then does this little caterpillar manage? I fear he must be sadly pinched.

Mrs. E. Not at all, my love; if his coat wants lengthening, he has only to add a new ring of hair or wool and silk to each end; and, if he wants it wider, he slits the case, not from end to end at once, which would leave him naked, but he first cuts each side about half way down, and then, after having filled

* Tinea sarcitella.

up the place, proceeds to cut the remaining half, so that, in fact, four enlargements are made, and four separate pieces put in. The colour of the coat, be it observed, is always the same as that of the stuff from which it is taken;—and thus, if its former colour be blue, and the insect, before enlarging it, be put upon red cloth, the circles at the end, and two stripes down the middle, will be red; and if placed alternately upon cloths of different hues, the insect's dress, like that of a harlequin, will be parti-coloured. How skilful and singular, then, are the creatures that commit such ravages in our garments! There is, however, a moth, Emma, which adorns its robe, as ladies used to do in other times, with furbelows. The body of the habit is a pipe lined with silk, and ornamented with furbelows puffed out; each flounce seems to mark the growth of the caterpillar; for Reaumur thinks that when it has out-grown the first, it adds a second division to its tube, and to that a third; they are rarely found to have more than three flounces; each furbelow is formed of two semi-circles joined together.

E. Mamma, that full-length portrait of my great aunt's aunt, that hangs on the stair-case, has a furbelowed gown. I'm sure I like the ladies' dresses now a great deal better.

Mrs. E. I hope you will always prefer simplicity to finery, Emma. But now let us go and *hear* the sailor-boy's history.

ELECTRICITY.

"Would you like to see something quite new to you?" said Mr. Elwood to his children, as he placed a mahogany case on the side-board, and sat down at the table where they, with their mother, were seated.

"Yes! Oh, yes, papa!" each of them eagerly exclaimed. Their kind father then took something from his pocket, rubbed it on a piece of woollen cloth, and, immediately after, held it over some small pieces of paper and bits of thread, when they flew towards it, and adhered to it for some time. To Frederick and Emma this was not only new, but puzzling; they could not conceive how it was done, nor were they much wiser, when, on asking Mr. Elwood what it was he held in his hand, he answered, "A piece of amber."

With the concern so often manifested for their pleasure and instruction, he gave them some account of the science of electricity, which arose out of observing the effect he had thus produced. With this, and a few other things like it, the ancients were acquainted; but they knew not that they were the results of a power pervading all material bodies; and

extensively concerned in all the operations of nature. Having stated this, he remarked that it was only by slow degrees this knowledge was acquired. The first step to arranging these facts was made by Dr. Gilbert, an English physician, who, in the year 1600, published a treatise on the magnet, in which he declared that several other bodies besides amber—such as the diamond, and many other precious stones, glass, sulphur, sealing-wax, rosin—can, by friction, or rubbing, be made to attract light substances; and he was thus led to discover a property common to them all. The Greek name for amber being electron, the bodies having it were called *electrics*, and the power they manifested was termed *electricity*. The observations of Newton, Boyle, and others, contributed in some degree to a knowledge of it; but, until the eighteenth century, little, comparatively, had been accomplished. He then informed them that a person named Hawksbee invented what is called an electrical machine, so that large supplies of electricity might be procured, and that others improved it, in which there is an electric, like the piece of amber—a rubber, like the piece of cloth—a conductor, to draw off, as it were, the electricity produced—an insulator, on which the person or thing to be electrified is to be placed, and some machinery for setting the electric in motion. The delight of the children was, however, greatly increased when he took out of the mahogany case a small

electrical machine—set it in action—placed them one by one on a stool with glass legs—told them how they might discharge or let off a Leyden jar, that thus they might partake of its charge of electricity—and, standing on the ground, drew sparks from them by touching them with his knuckle!

E. Why, papa, I see you get from the conductor sometimes a stream of *little* lightning.

Mr. E. Dr. Franklin has proved that the electrical property is in lightning.

F. How, papa, did he do that?

Mr. E. He entertained the idea for some time before he had a favourable opportunity of trying its truth. A spire, however, was about to be erected in Philadelphia, which he thought would enable him to make the experiment, but, one day seeing a boy flying a kite, it suddenly occurred to him that here was a method of reaching the clouds preferable to any other. Accordingly, he immediately took a large silk handkerchief, and, stretching it over two cross sticks, formed, in this manner, his simple apparatus for drawing down the lightning from its cloud. Soon after, seeing a thunder-storm approaching, he took a walk into a field in the neighbourhood of the city, in which there was a shed, but letting no one know, except his son, whom he took to assist him in raising the kite.

E. I wonder what he did then.

Mr. E. The kite being raised, he fastened a key to the lower end of the hempen string; and then, insulating it by fastening it to a post with silk, he placed himself under the shed, and waited the result. For some time no signs of electricity appeared. A cloud, apparently charged with lightning, had even passed over them without producing any effect. At length, however, just as Franklin was beginning to despair, he saw some loose threads of the hempen string rise and stand erect, exactly as if they had been repelled from each other by being charged with electricity. He immediately presented his knuckle to the key, and, to his inexpressible delight, drew from it the well-known electrical spark. As the rain increased, the cord became a better conductor, and the key gave out its electricity copiously.

F. Dear! How delighted he must have been!

Mr. E. He afterwards brought down the lightning into his house, and performed with it, at his leisure, all the experiments that could be performed with electricity. With these, it seems, he was accustomed to amuse his friends. In one of his letters he says, "Chagrined a little that we have hitherto been able to do nothing in this way of use to mankind, and the hot weather coming on, when electrical experiments are not so agreeable, it is proposed to put an end to them for this season somewhat humourously, in a party of pleasure on the banks of *Skuylkill.* Spirits

at the same time are to be fired by a spark sent from side to side through the river, without any other conductor but the water—an experiment which we have some time since performed to the amusement of many. A turkey is to be killed for dinner by the *electrical shock*, and roasted by the *electrical jack*, before a fire kindled by the *electrical bottle;* when the healths of all the famous electricians in *England, Holland, France, and Germany,* are to be drunk in *electrified bumpers;* under the discharge of guns from the *electrical battery!*"

E. Oh, that's very funny! But did not his discovery become useful?

Mr. E. It did. It suggested to him the idea of a method of preserving buildings from lightning, which is not only effectual, but extremely simple and cheap; consisting, as it does, of nothing more than attaching to the building a pointed metallic rod, rising higher than any part of it, and communicating at the lower end with the ground. The lightning is sure to seize upon this rod in preference to any other part of the building, and thus it is conducted to the earth, and prevented doing any injury.

F. And so, papa, it is clear that electricity was in the thunder-cloud, long—very long before it was found to be in amber.

Mr. E. Just so; and, what is more, that, while the electrical machine was not invented till lately, living ones existed from the creation of the world.

E. Living ones, papa! How can an electrical machine be alive?

Mr. E. I will tell you. There is an animal called the electrical eel,* which possesses the singular property of giving a shock to any body, or any number of bodies connected together, just as it may be done by the machine. Dr. Williamson repeatedly proved this, and, while another person provoked the fish, he put his hand into the water, at the distance of three feet from it, and felt a sensation in the joints of his fingers like that produced by electricity. Some small fish were thrown into the water, and the animal immediately stunned and swallowed them. Dr. Williamson put his hand into the water, and had a fish thrown in at some distance. The eel swam up to it, and, at first, turned away without offering it any violence; after a little while he returned, and, looking stedfastly at it a few seconds, gave it a shock, by which it instantly turned upon its back, and became motionless. The Dr., at that very instant, felt the same sensation in his fingers, as when he put his hand into the water before. A fish was afterwards struck, but not quite killed; when the eel perceived this, he returned, and at a second shock, evidently more severe than the former, rendered it motionless. Indeed, from a long series of experiments, it appeared that the properties of the fish partook so nearly of

* Gymnotus electricus.

the nature of electricity, that whatever would convey the electrical fluid would also convey the fluid discharged by the eel, and vice versa. He, however, was never able to observe that any spark was produced on contact.

F. Is the fish very powerful?

Mr. E. It is. Mr. Bryant mentions an instance of the shock being felt through a considerable thickness of wood. One morning, while he was standing by, as the servant was emptying a tub, which contained one of these fish, he had lifted it entirely from the ground, and was pouring off the water to renew it, when he received a shock so violent as occasioned him to let the tub fall. Mr. B. then called another person to his aid, and told them to lift up the tub together, each taking hold on the outside; but when they were pouring off the remainder of the water, each of them received so smart a shock that they were compelled to desist. Other cases are still more singular. A negro, who attempted to grasp a large fish firmly with his hands, had both his arms palsied. One of these fish being shaken from a net upon grass, a sailor, notwithstanding all that could be said to prevent him, insisted on taking it up, when he fell down in a fit, and it was with difficulty that his senses were restored. He said that the instant he touched it "the cold ran swiftly up his arm into his body, and pierced him to the heart."

E. Of what use is this power, papa?

Mr. E. It seems designed in part for the defenee of the fish. Dr. Williamson found that it did not use it except it was irritated; he has passed his hand along the baek and sides from head to tail, and even lifted part of its body out of the water, without its attempting to injure him. It appears, however, to be principally used for securing food; the eels being destitute of teeth, they would otherwise be scarcely able to seize it. Thus the benevolence of God has compensated them, as he has done other creatures, for the want they discover.

F. Where, papa, are these fish found?

Mr. E. They are peculiar to South America, where they are found only in the rocky parts of rivers, at a great distance from the sea. The torpedo,* or electric ray, however, is found in most of the European seas, and it is by no means uncommon on the British coasts. This fish possesses the same power of benumbing its prey as the electric eel, and many experiments have been made upon it with similar effeet.

E. Can you describe, papa, the electrical machine which these ereatures have?

Mr. E. The organs of the eel that produee this wonderful accumulation of electric matter, form nearly one half of the fish in which they are placed; and perhaps compose more than one-third of the whole

* Raia torpedo.

animal. There are two pairs of these organs, one on each side. Their structure is very simple and regular, consisting only of flat partitions, with cross divisions between them: the partitions are thin membranes, placed nearly parallel to one another, and of different lengths and breadths. They are furnished with many pairs of nerves; but *how*, with this apparatus, such effects have been produced, has not yet been satisfactorily explained. We are equally ignorant of the way in which the torpedo becomes electrical, by means far more complicated and numerous. In these creatures they are composed of perpendicular columns reaching from the upper to the under surface, the number of them varying considerably in different animals. In a very large torpedo they amounted in one organ to 1182.

In what a world of wonders do we live! They appear in inanimate matter; and living beings form a continuous and uninterrupted chain:

> Each shell, each crawling insect, holds a rank
> Important in the plan of Him, who framed
> This scale of beings; holds a rank, which lost
> Would break the chain, and leave a gap behind
> Which nature's self would rue.

From the contemplation of the boundless variety of nature, let us always rise to the great First Cause; and thus combine, with the improvement of the understanding, the moral culture of the heart.

John Westley and Co., 27, Ivy Lane.